FUJITSU SEMICONDUCTOR
CONTROLLER MANUAL

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FR-V FAMILY
SOFTUNE™ WORKBENCH
USER'S MANUAL
for V6

FUJITSU

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FUJITSU LIMITED

PREFACE

■ What is the SOFTUNE Workbench ?

SOFTUNE Workbench is support software for developing programs for the FR-V families of microprocessors.

It is a combination of a development manager, simulator debugger, emulator debugger, monitor debugger, and an integrated development environment for efficient development.

■ Purpose of this manual and target readers

This manual explains the functions of SOFTUNE Workbench. This manual is intended for engineers developing various types of products using SOFTUNE Workbench. Be sure to read this manual completely.

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■ Organization of Manual

This manual consists of two chapters.

Chapter 1 Standard Functions

This chapter describes the standard functions on the SOFTUNE Workbench.

Chapter 2 Dependence Functions

This chapter describes the functions depending on the each debugger.

Chapter 3 Multi-core Development Environment

In this chapter, function for development environment for multi-core is explained.

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Reading This Manual

■ Product Names

In this manual, product names are abbreviated as follows:

The Microsoft® Windows® 98 operating system is abbreviated to Windows 98.

The Microsoft® Windows® Millennium Edition operating system is abbreviated to Windows Me.

The Microsoft® Windows® NT® Workstation operating system Version 4.0 and the Microsoft® Windows® NT® Server network operating system Version 4.0 are abbreviated to Windows NT 4.0.

Microsoft® Windows® 2000 Professional operating system,
Microsoft® Windows® 2000 Server operating system,
Microsoft® Windows® 2000 Advanced Server operating system,
Microsoft® Windows® 2000 Datacenter Server operating system are abbreviated to Windows 2000.

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CHAPTER 1
STANDARD FUNCTIONS

This chapter describes the standard functions on the SOFTUNE Workbench.

1.1 Workspace Management Function
1.2 Project Management Function
1.3 Project Dependence
1.4 Make/Build Function
1.5 Include Dependencies Analysis Function
1.6 Functions of Setting Tool Options
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1.16 Line Assembly and Disassembly
1.17 Symbolic Debugging
1.18 I/O Operations

1.1 Workspace Management Function

This section explains the workspace management function of SOFTUNE Workbench.

■ Workspace

SOFTUNE Workbench uses workspace as a container to manage two or more projects including subprojects.

For example, a project that creates a library and a project that creates a target file using the project can be stored in one workspace.

■ Workspace Management Function

To manage two or more projects, workspace manages the following information:

- Project
- Active project
- Subproject

■ Project

The operation performed in SOFTUNE Workbench is based on the project. The project is a set of files and procedures necessary for creation of a target file. The project file contains all data managed by the project.

■ Active Project

The active project is basic to workspace and undergoes [Make], [Build], [Compile/Assemble], [Start Debug], and [Update Dependence] in the menu. [Make], [Build], [Compile/Assemble], and [Update Dependence] affect the subprojects within the active project.

If workspace contains some project, it always has one active project.

■ Subproject

The subproject is a project on which other projects depend. The target file in the subproject is linked with the parent project of the subproject in creating a target file in the parent project.

This dependence consists of sharing target files output by the subproject, so a subproject is first made and built. If making and building of the subproject is unsuccessful, the parent project of the subproject will not be made and built.

The target file in the subproject is however not linked with the parent project when:

- An absolute (ABS)-type project is specified as a subproject.
- A library (LIB)-type project is specified as a subproject.

■ Restrictions on Storage of Two or More Projects

Only one REALOS-type project can be stored in one workspace.

1.2 Project Management Function

This section explains the project management function of SOFTUNE Workbench.

■ Project Management Function

The project manages all information necessary for development of a microcontroller system. Especially, its major purpose is to manage information necessary for creation of a target file.

The project manages the following information:

- Project configuration
- Active project configuration
- Information on source files, include files, other source files, library files
- Information on tools executed before and after executing language tools (customize build function)

■ Project Configuration

The project configuration is a series of settings for specifying the characteristics of a target file, and making, building, compiling and assembling is performed in project configurations.

Two or more project configurations can be created in a project. The default project configuration name is Debug. A new project configuration is created on the setting of the selected existing project configuration. In the new project configuration, the same files as those in the original project configuration are always used.

By using the project configuration, the settings of programs of different versions, such as the optimization level of a compiler and MCU setting, can be created within one project.

In the project configuration, the following information is managed:

- Name and directory of target file
- Information on options of language tools to create target file by compiling, assembling and linking source files
- Information on whether to build file or not
- Information on setting of debugger to debug target file

■ Active Project Configuration

The active project configuration at default undergoes [Make], [Build], [Compile/Assemble], [Start Debug], and [Update Dependence].

The setting of the active project configuration is used for the file state displayed in the SRC tab of project window and includes files detected in the Dependencies folder.

1.3 Project Dependence

This section explains the project dependence of SOFTUNE Workbench.

■ Project Dependence

If target files output by other projects must be linked, a subproject is defined in the project required in [Project Dependence] in the [Project] menu. The subproject is a project on which other projects depend.

By defining project dependence, a subproject can be made and built to link its target file before making and building the parent project.

The use of project dependence enables simultaneous making and building of two or more projects developed in one workspace.

A project configuration in making and building a subproject in [Project Configuration]-[Build Configuration] in the [Project] menu can be specified.

1.4 Make/Build Function

This section explains the project dependence of SOFTUNE Workbench.

■ Make Function

Make function generates a target file by compiling/assembling only updated source files from all source files registered in a project, and then joining all required object files.

This function allows compiling/assembling only the minimum of required files. The time required for generating a target file can be sharply reduced, especially, when debugging.

For this function to work fully, the dependence between source files and include files should be accurately grasped. To do this, SOFTUNE Workbench has a function for analyzing include dependence. To perform this function, it is necessary to understand the dependence of a source file and include file. SOFTUNE Workbench has the function of analyzing the include file dependence. For details, see Section "1.5 Include Dependencies Analysis Function".

■ Build Function

Build function generates a target file by compiling/assembling all source files registered with a project, regardless of whether they have been updated or not, and then by joining all required object files. Using this function causes all files to be compiled/assembled, resulting in the time required for generating the target file longer. Although the correct target file can be generated from the current source files.

The execution of Build function is recommended after completing debugging at the final stage of program development.

Note:

When executing the Make function using a source file restored from backup, the integrity between an object file and a source file may be lost. If this happens, executing the Build function again.

1.4.1 Customize Build Function

This section describes the SOFTUNE Workbench function to set the Customize Build function.

■ Customize Build Function

In SOFTUNE Workbench, different tools can be operated automatically before and after executing the Assembler, Compiler, Linker, Librarian, Converter, or Configurator started at Compile, Assemble, Make, or Build.

The following operations can be performed automatically during Make or Build using this function:

- Starting the syntax check before executing the Compiler,
- After executing the Converter, starting the S-format binary Converter (m2bs.exe) and converting Motorola S-format files to binary format files.

■ Options

An option follows the tool name to start a tool from SOFTUNE Workbench. The options include any file name and tool-specific options. SOFTUNE Workbench has the macros indicating that any file name and tool-specific options are specified as options.

If any character string other than parameters is specified, it is passed directly to the tool. For details about the parameters, see Section "1.11 Macro Descriptions Usable in Manager".

■ Precautions

When checking [Use the Output window], note the following:

- Once a tool is activated, Make/Build suspends until the tool is terminated.
- The Output window must not be used with a tool using a wait state for user input while the tool is executing. The user can not perform input while the Output window is in use, so the tool cannot be terminated.

To forcibly terminate the tool, select the tool on the Task bar and input Control - C, or Control - Z.

■ Macro List

The Setup Customize Build dialog provides a macro list for macro input. The build file, load module file, project file submenus indicate their sub-parameters specified.

The environment variable brackets must have any item; otherwise, resulting in an error.

Table 1.4-1 Macro List

Macro List	Macro Name
Build file	%(FILE)
Load module file	%(LOADMODULEFILE)
Project file	%(PRJFILE)
Workspace file	%(WSPFILE)
Project directory	%(PRJPATH)
Target file directory	%(ABSPATH)
Object file directory	%(OBJPATH)
List file directory	%(LSTPATH)
Project construction name	%(PRJCONFIG)
Environment variable	%(ENV[])
Temporary file	%(TEMPFILE)

1.5 Include Dependencies Analysis Function

This section describes the function of the Include Dependencies Analysis.

■ Analyzing Include Dependencies

A source file usually includes some include files. When only an include file has been modified leaving a source file unchanged, SOFTUNE Workbench cannot execute the Make function unless it has accurate and updated information about which source file includes which include files.

For this reason, SOFTUNE Workbench has a built-in Include Dependencies Analysis function. This function can be activated by selecting the [Project] -[Include Dependencies] command. By using this function, uses can know the exact dependencies, even if an include file includes another include file.

SOFTUNE Workbench automatically updates the dependencies of the compiled/assembled files.

Note:

When executing the [Project] - [Include Dependencies] command, the Output window is redrawn and replaced by the dependencies analysis result.

If the contents of the current screen are important (error message, etc.), save the contents to a file and then execute the Include Dependencies command.

1.6 Functions of Setting Tool Options

This section describes the functions to set options for the language tools activated from SOFTUNE Workbench.

■ Function of Setting Tool Options

To create a desired target file, it is necessary to specify options for the language tools such as a compiler, assembler, and linker. SOFTUNE Workbench stores and manages the options specified for each tool in project configurations.

Tool options include the options effective for all source files (common options) and the options effective for specific source files (individual options). For details about the option setting, refer to Section 4.5.5, SOFTUNE Workbench Operation Manual.

- Common options

  These options are effective for all source files (excluding those for which individual options are specified) stored in the project.

- Individual options

  These options are compile/assemble options effective for specific source files. The common options specified for source files for which individual options are specified become invalid.

■ Tool Options

In SOFTUNE Workbench, the macros indicating that any file name and directory name are specified as options.

If any character string other than parameters is specified, it is passed directly to the tool. For details about the tool options for each tool, see Section "1.11 Macro Descriptions Usable in Manager".

■ Reference Section

Setup Project

Development Environment

1.7 Error Jump Function

This section describes the error jump function in SOFTUNE Workbench.

■ Error Jump Function

When an error, such as a compile error occurs, double-clicking the error message in the Output window opens the source file where the error occurred and automatically moves the cursor to the error line. This function permits efficient removal of compile errors, etc.

The SOFTUNE Workbench Error Jump function analyzes the source file names and line number information embedded in the error message displayed in the Output window, opens the matching file, and jumps automatically to the line.

The location where a source file name and line number information are embedded in an error message, varies with the tool outputting the error.

An error message format can be added to an existing one or modified into a new one. However, the modify error message formats for pre-installed Fujitsu language tools are defined as part of the system, these can not be modified.

A new error message format should be added when working the Error Jump function with user registed. To set Error Jump, execute the [Setup] - [Error] command.

■ Syntax

An error message format can be described in Syntax. SOFTUNE Workbench uses macro descriptions as shown in Table 1.7-1 to define such formats.

To analyze up to where %f, %h, and %* continue, SOFTUNE Workbench uses the character immediately after the above characters as a delimiter. Therefore, the description until a character that is used as a delimiter re-appears, is interpreted as a file name or a keyword for help, or is skipped over. To use % as a delimiter, describe as %%. The %[char] macro skips over as long as the specified character continues in parentheses. To specify "]" as a skipped character to be skipped, describe it as "\]". Blank characters in succession can be specified with a single blank character.

Table 1.7-1 Special Characters for Analyzing Error Messages

Characters	Semantics
%f	Interpret as source file name and inform editor.
%l	Interpret as line number and inform editor.
%h	Become keyword when searching help file.
%*	Skip any desired character.
%[char]	Skip as long as characters in [ ] continues.

[Example]

*** _%f(%l) _%h: or, %[*] _%f(%l) _%h:

The first four characters are "*** _", followed by the file name and parenthesized page number, and then the keyword for help continues after one blank character.
This represents the following message:

*** _C:\Sample\sample.c(100) _E4062C: Syntax Error: near /int.

■ Reference Section

Setup Error Jump

1.8 Editor Functions

This section describes the functions of the SOFTUNE Workbench built-in standard editor.

■ Standard Editor

SOFTUNE Workbench has a built-in editor called the standard editor. The standard editor is activated as the Edit window in SOFTUNE Workbench. As many Edit windows as are required can be opened at one time.

The standard editor has the following functions in addition to regular editing functions.

- Keyword marking function in C/C++/assembler source file

  Displays reserved words, such as if and for, in different color
- Error line marking function

  The error line can be viewed in a different color, when executing Error Jump.
- Tag setup function

  A tag can be set on any line, and instantaneously jumps to the line. Once a tag is set, the line is displayed in a different color.
- Ruler, line number display function

  The Ruler is a measure to find the position on a line; it is displayed at the top of the Edit window. A line number is displayed at the left side of the Edit window.
- Automatic indent function

  When a line is inserted using the Enter key, the same indent as the preceding line is set automatically at the inserted line. If the space or tab key is used on the preceding line, the same use is set at the inserted line as well.
- Function to display, Line Feed code, and Tab code

  When a file includes a Line Feed code, and Tab code, these codes are displayed with special symbols.
- Undo function

  This function cancels the preceding editing action to restore the previous state. When more than one character or line is edited, the whole portion is restored.
- Tab size setup function

  Tab stops can be specified by defining how many digits to skip when Tab codes are inserted. The default is 8.
- Font changing function

  The font size for characters displayed in the Edit window can be selected.

■ Reference Section

Edit Window (The Standard Editor)

1.9 Storing External Editors

This section describes the function to set an external editor in SOFTUNE Workbench.

■ External Editor

SOFTUNE Workbench has a built-in standard editor, and use of this standard editor is recommended. However, another accustomed editor can be used, with setting it, instead of an edit. There is no particular limit on which editor can be set, but some precautions (below) may be necessary. Use the [Setup] - [Editor] command to set an external editor.

■ Precautions

- Error jump function

  The Error Jump cannot move the cursor to an error line if the external editor does not have a function to specify the cursor location when activated.

- File save at compiling/assembling

  SOFTUNE Workbench cannot control an external editor. Always save the file you are editing before compiling/assembling.

■ Setting Options

When activating an external editor from SOFTUNE Workbench, options must be added immediately after the editor name. The names of file to be opened by the editor and the initial location of the cursor (the line number) can be specified. SOFTUNE Workbench has a set of special parameters for specifying any file name and line number, as shown in Table 1.9-1. If any other character are described by these parameters, such character are passed as is to the editor.

%f (File name) is determined as follows:

1. If the focus is on the SRC tab of project window, and if a valid file name is selected, the selected file name becomes the file name.
2. When a valid file name cannot be acquired by the above procedure, the file name with a focus in the built-in editor becomes the file name.

Also filenames cannot be given double-quotes in the expansion of %f macros.

%x (project path) is determined as follows:

1. If a focus is on the SRC tab of project window and a valid file name is selected, the project path is a path to the project in which the file is stored.
2. If no path is obtained, the project path is a path to the active project.

Therefore, it is necessary for you to provide double-quotes for %f. Depending on the editor, there are line numbers to which there will be no correct jump if the entire option is not given double-quotes.

Table 1.9-1 Parameters Used in Option Setups (For External Editors)

Parameter	Semantics
%%	Means specifying % itself
%f	Means specifying file name
%l	Means specifying line number
%x	Means specifying project path

■ Reference Section

Editor Setup

■ Example of Optional Settings

Editor name	: Argument
(A) WZ Editor V4.0	: %f /j%l
(B) MIFES V1.0	: %f /j%l
(C) UltraEdit32	: %f/%l/1
(D) TextPad32	: %f(%l)
(E) PowerEDITOR	: %f -g%l
(F) Codewright32	: %f -g%l
(G) Hidemaru for Win3.1/95	: /j%l:1 %f
(H) ViVi	: /line=%l %f

Note:

Regarding execution of error jump in Hidemaru:

To execute error jump in Hidemaru used as an external editor, use the [Others] - [Operating Environment] - [Exclusive Control] command, and then set "When opening the same file in Hidemaru" and "Opening two identical files is inhibited".

1.10 Storing External Tools

This section describes the SOFTUNE Workbench function to set an external tool.

■ External Tools

A non-standard tool not attached to SOFTUNE Workbench can be used by setting it as an external tool and by calling it from SOFTUNE Workbench. Use this function to coordinate with a source file version control tool.

If a tool set as an external tool is designed to output the execution result to the standard output and the standard error output through the console application, the result can be specified to the SOFTUNE Workbench Output window. In addition, the allow description of additional parameters each time the tool is activated.

To set an external tool, use the [Setup] - [Tool] command.

To select the title of a set tool, use the [Setup] - [Activating Tool] command.

■ Setting Options

When activating an external tool from SOFTUNE Workbench, options must be added immediately after the tool name. Specify the file names, and unique options, etc.

SOFTUNE Workbench has a set of special parameters for specifying any file name and unique tool options.

If any characters described other than these parameters, such characters are passed as is to the external tool.

For details about the parameters, see Section "1.11 Macro Descriptions Usable in Manager".

■ Precautions

When checking [Use the Output window], note the following:

- Once a tool is activated, neither other tools nor the compiler/assembler can be activated until the tool is terminated.
- The Output window must not be used with a tool using a wait state for user input while the tool is executing. The user can not perform input while the Output window is in use, so the tool cannot be terminated.

To forcibly terminate the tool, select the tool on the Task bar and input Control - C, or Control - Z.

■ Reference Section

Setting Tools

Start an External Tool

1.11 Macro Descriptions Usable in Manager

This section explains the macro descriptions that can be used in the manager of SOFTUNE Workbench.

■ Macros

SOFTUNE Workbench has special parameters indicating that any file name and tool-specific options are specified as options.

The use of these parameters as tool options eliminates the need for options specified each time each tool is started.

The type of macro that can be specified and macro expansion slightly vary depending on where to describe macros. The macros usable for each function are detailed below. For the macros that can be specified for "Error Jump" and "External Editors" see Sections "1.7 Error Jump Function" and "1.9 Storing External Editors".

■ Macro List

The following is a list of macros that can be specified in SOFTUNE Workbench.

The macros usable for each function are listed below.

- External tools: Table 1.11-1 and Table 1.11-2
- Customize build: Table 1.11-1 and Table 1.11-2
- Tool options: Table 1.11-2

The directory symbol \ is added to the option directories in Table 1.11-1 but not to the macro directories in Table 1.11-2.

The sub-parameters in Table 1.11-3 can be specified in %(FILE),

%(LOADMOUDLEFILE), %(PRJFILE), and %(WSPFILE).

The sub-parameter is specified in the form of %(PRJFILE[PATH]).

If the current directory is on the same drive, the relative path is used. The current directory is the workspace directory for %(PRJFILE), and %(WSPFILE), and the project directory for other than these.

Table 1.11-1 List of Macros That Can BE Specified 1

Parameter	Meaning
%f	Passed as full-path name of file. *1
%F	Passed as main file name of file. *1
%d	Passed as directory of file. *1
%e	Passed as extension of file. *1
%a	Passed as full-path name of load module file.
%A	Passed as main file name of load module file. *2
%D	Passed as directory of load module file. *2
%E	Passed as extension of load module file. *2
%x	Passed as directory of project file. *2
%X	Passed as main file name of project file. *2
%%	Passed as %.

Table 1.11-2 List of Macros That Can BE Specified 1

Parameter	Meaning
%(FILE)	Passed as full-path name of file. *1
%(LOADMODULEFILE)	Passed as full-path name of load module file. *2
%(PRJFILE)	Passed as full-path name of project file. *2
%(WSPFILE)	Passed as full-path name of workspace file. *3
%(PRJPATH)	Passed as directory of project file. *2
%(ABSPATH)	Passed as directory of target file. *2
%(OBJPATH)	Passed as directory of object file. *2
%(LSTPATH)	Passed as directory of list file. *2
%(PRJCONFIG)	Passed as project configuration name. *2
%(FNV[Environment variable])	Environment variable specified in environment variable brackets is passed.
%(TEMPFILE)	Temporary file is created and its full-path name is passed. *4

*1: The macros are determined as follows:

- Customize build
  1. Source file before and after executing compiler and assembler
  2. Target file before and after executing linker, librarian and converter
  3. Configuration file before and after executing configuration

- Tool options
  Null character
- Others
  1. File as focus is on the SRC tab of project window and valid file name is selected
  2. File on which focus is in internal editor as no valid file name can be obtained in 1
  3. Null character if no valid file name can be obtained

*2: The macros are determined as follows:

- Customize build and tool options
  Information on configuration of project under building, making, compiling and assembling
- Others
  1. Information on active configuration of active project in which file is stored as focus is on the SRC tab of project window and valid file name is selected
  2. Information on active configuration of active project if no valid file name can be obtained in 1

*3: Only project files in the workspace project format can be used for macros indicated by the macro.

*4: Data in the temporary file can be specified only for customize build.

Table 1.11-3 Lists of Sub Parameters 1

Sub parameter	Meaning
[PATH]	Directory of file
[RELPATH]	Relative path of file
[NAME]	Main file name of file
[EXT]	Extension of file
[SHORTFULLNAME]	Full path name of short file
[SHORTPATH]	Directory of short file
[SHORTNAME]	Main file name of short file
[FOLDER]	Name of folder in which files are stored in SRC tab of project window (Can be specified only in %(FILE).) *

*: The macro can be used only in workspace-compatible Workbench. It is not expanded in workspace-incompatible Workbench.

■ Examples of Macro Expansion

If the following workspace is opened, macro expansion is performed as follows:

Workspace: C:/Wsp/ Wsp.wsp
Active project: C:/ Wsp/ Sample/ Sample.prj
Active project configuration - Debug
Object directory: C:/ Wsp/ Sample/ Debug/ Obj/

Subproject: C:/ Subprj/ Subprj. prj
Active project configuration - Release
Object directory: C:/ Subprj/ Release/ Obj/
Target file: C:/ Subprj/ Release/ Abs/ Subprj. abs

[Example] Macro expansion in external tools
Focus is on Subprj project in SRC tab of project window

%a:	C:/ Subprj/ Release/ Abs/ Subprj. abs
%A:	SUBPRJ.abs
%D:	C:/ Subprj/ Release/ Abs/
%E:	.abs
%(FILE [FOLDER]):	Source Files/ Common
%(PRJFILE):	C:/ Subprj/ Subprj. prj

Focus is not in SRC tab of project window

%a:	C:/ Wsp/ Sample/ Debug/ Abs/ Sample. abs
%A:	Sample. abs
%D:	C:/ Wsp/ Sample/ Debug/ Abs/
%(PRJFILE):	C:/ Wsp/ Sample/ Sample. prj

[Example] Macro expansion in customize build
Release configuration of Subprj project is built.

%(FILE):	C:/ Subprj/ Long Name File.c
%(FILE [PATH]):	C:/ Subprj
%(FILE [RELPATH]):	
%(FILE [NAME):	Long Name File
%(FILE [EXT]):	.c
%(FILE [SHORTFULLNAME]):	C:/ Subprj/ Long Fi to 1.c
%(FILE [SHORTPATH]):	C:/ Subprj
%(FILE [SHORINAME]):	Long Fi to 1
%(PRJFILE [RELPATH]):	../ Subprj
%(PRJPATH):	C:/ Subprj
%(OBJPATH):	C:/ Subprj/ Release/ Obj
%(PRJCONFIG):	Relase
%(ENV [FETOOL]):	C:/ Softune
%(TEMPFILE):	C:/ Subprj /Relase/Opt/_fs1056.TMP

[Example] Macro expansion in tool options
Release configuration of Subprj project is build.

%(FILE):	
%(PRJFILE [RELPATH]):	../Subprj
%(PRJPATH):	C:/Subprj
%(OBJPATH):	C:/Subprj/Release/ Obj
%(PRJCONFIG):	Relase
%(ENV [FETOOL]):	C:/Softtune

1.12 Setting Operating Environment

This section describes the functions for setting the SOFTUNE Workbench operating environment.

■ Operating Environment

Set the environment variables for SOFTUNE Workbench and some basic items for the Project.

To set the operating environment, use the [Setup]-[Development] command.

- Environment Variables

  Environment variables are variables that are referred to mainly using the language tools activated from SOFTUNE Workbench. The semantics of an environment variable are displayed in the lower part of the Setup dialog. However, the semantics are not displayed for environment variables used by tools added later to SOFTUNE Workbench.

  When SOFTUNE Workbench and the language tools are installed in a same directory, it is not especially necessary to change the environment variable setups.

- Basic setups for Project

  The following setups are possible.

- Open the previously worked-on Project at start up

  When starting SOFTUNE Workbench, it automatically opens the last worked-on Project.

- Display options while compiling/assembling

  Compile options or assemble options can be viewed in the Output window.

- Save dialog before closing Project

  Before closing the Project, a dialog asking for confirmation of whether or not to save the Project to the file is displayed. If this setting is not made, SOFTUNE Workbench automatically saves the Project without any confirmation message.

- Save dialog before compiling/assembling

  Before compiling/assembling, a dialog asking for confirmation of whether or not to save a source file that has not been saved is displayed. If this setting is not made, the file is saved automatically before compile/assemble/make/build.

- Termination message is highlighted at Make/Build

  At Compile, Assemble, Make, or Build, the display color of termination messages (Abort, No Error, Warning, Error, Fatal error, or Failing During start) can be changed freely by the user.

■ Reference Section

Development Environment

Note:

Because the environment variables set here are language tools for the SOFTUNE Workbench, the environment variables set on previous versions of SOFTUNE cannot be used. In particular, add the set values of [User Include Directory] and [Library Search Directory] to [Tool Options Settings].

1.13 Debugger Types

This section describes the functions of SOFTUNE Workbench debuggers.

■ Debug Function

SOFTUNE Workbench integrates three types of debugger: a simulator debugger, emulator debugger, and monitor debugger. Any one can be selected depending on the requirement.

■ Simulator Debugger

The simulator debugger simulates the MCU operations (executing instructions, memory space, I/O ports, interrupts, reset, etc.) with software to evaluate a program.

It is used for evaluating an uncompleted system and operation of individual units, etc.

■ Emulator Debugger

The emulator debugger is software to evaluate a program by controlling an In-Circuit Emulator (ICE) from a host through a communications line (RS-232C or USB).

Before using this debugger, the ICE must be initialized.

■ Monitor Debugger

The monitor debugger evaluates a program by putting it into an evaluation system and by communicating with a host. An RS-232C interface and an area for the debug program are required within the evaluation system.

For further information on the MCU-related items, see Chapter 2 and later in this manual.

1.14 Memory Operation Functions

This section describes the memory operation functions.

■ Functions for Memory Operations

- Display/Modify memory data
  Memory data can be display in the Memory window and modified.
- Fill
  The specified memory area can be filled with the specified data.
- Copy
  The data in the specified memory area can be copied to another area.
- Compare
  The data in the specified source area can be compared with data in the destination area.
- Search
  Data in the specified memory area can be searched.
  For further details of the above functions, refer to the Operation Manual 3.11 Memory Window.
- Display/Modify C/C++ variables
  The names of variables in a C/C++ source file can be displayed in the Watch window and modified.
- Setting Watch point
  By setting a watch point at a specific address, its data can be displayed in the Watch window.
  For further details of the above functions, refer to the Operation Manual 3.13 Watch Window.

1.15 Register Operations

This section describes the register operations.

■ Register Operations

The Register window is opened when the [View] - [Register] command is executed. The register and flag values can be displayed in the Register window.

For further details about modifying the register value and the flag value, refer to the Operation Manual 4.4.4 Register.

The name of the register and flag varies depending on each MCU in use. For the list of register names and flag names for the MCU in use, refer to the Operational Manual Appendix.

■ Reference Section

Register Window

1.16 Line Assembly and Disassembly

This section describes line assembly and disassembly.

■ Line Assembly

To perform line-by-line assembly (line assembly), right-click anywhere in the Disassembly window to display the short-cut menu, and select [Line Assembly]. For further details about assembly operation, refer to the Operation Manual 4.4.3 Assembly.

■ Disassembly

To display disassembly, use the [View]-[Disassembly] command. By default, disassembly can be viewed starting from the address pointed by the current program counter (PC). However, the address can be changed to any desired address at start-up.

Disassembly for an address outside the memory map range cannot be displayed. If this is attempted, "???" is displayed as the mnemonic.

■ Reference Section

Disassembly Window

1.17 Symbolic Debugging

The symbols defined in a source program can be used for command parameters (address). There are three types of symbols as follows:

- Global Symbol
- Static Symbol within Module (Local Symbol within Module)
- Local Symbol within Function

■ Types of Symbols

A symbol means the symbol defined while a program is created, and it usually has a type. Symbols become usable by loading the debug information file.

There are three types of symbols as follows:

- Global symbol

  A global symbol can be referred to from anywhere within a program. In C/C++, variables and functions defined outside a function without a static declaration are in this category. In assembler, symbols with a PUBLIC declaration are in this category.

- Static symbol within module (Local symbol within module)

  A static symbol can be referred to only within the module where the symbol is defined.

  In C/C++, variables and functions defined outside a function with a static declaration are in this category. In assembler, symbols without a PUBLIC declaration are in this category.

- Local symbol within function

  A local symbol within a function exists only in C/C++. A static symbol within a function and an automatic variable are in this category.

- Static symbol within function

  Out of the variables defined in function, those with static declaration.

- Automatic variable

  Out of the variables defined in function, those without static declaration and parameters for the function.

■ Setting Symbol Information

Symbol information in the file is set with the symbol information table by loading a debug information file. This symbol information is created for each module.

The module is constructed for each source file to be compiled in C/C++, in assembler for each source file to be assembled in assembler.

The debugger automatically selects the symbol information for the module to which the PC belongs to at abortion of execution (Called "the current module"). A program in C/C++ also has information about which function the PC belongs to.

■ Line Number Information

Line number information is set with the line number information table in SOFTUNE Workbench when a debug information file is loaded. Once registered, such information can be used at anytime thereafter. Line number is defined as follows:

[Source File Name] $Line Number

1.17.1 Referring to Local Symbols

This section describes referring to local symbols and Scope.

■ Scope

When a local symbol is referred to, Scope is used to indicate the module and function to which the local symbol to be referred belongs.

SOFTUNE Workbench automatically scopes the current module and function to refer to local symbols in the current module with preference. This is called the Auto-scope function, and the module and function currently being scoped are called the Current Scope.

When specifying a local variable outside the Current Scope, the variable name should be preceded by the module and function to which the variable belongs. This method of specifying a variable is called a symbol path name or a Search Scope.

■ Moving Scope

As explained earlier, there are two ways to specify the reference to a variable: by adding a Search Scope when specifying the variable name, and by moving the Current Scope to the function with the symbol to be referred to. The Current Scope can be changed by displaying the Call Stack dialog and selecting the parent function. For further details of this operation, refer to the Operation Manual 4.6.6 Stack. Changing the Current Scope as described above does not affect the value of the PC.

By moving the current scope in this way, you can search a local symbol in parent function with precedence.

■ Specifying Symbol and Search Procedure

A symbol is specified as follows:

```
[ [ Module Name ] [\Function name] \] Symbol Name
```

C++ symbol can be specified as follows with the scope operator:

```
[ [ Class Name ] [Function name] \] Symbol Name
```

When a symbol is specified using the module and function names, the symbol is searched. However, when only the symbol name is specified, the search is made as follows:

- Local symbols in function in Current Scope
- The class member which can access with the this pointer
- Static symbols in module in Current Scope
- Global symbols

If a global symbol has the same name as a local symbol in the Current Scope, specify "\" or "::" at the start of global symbol. By doing so, you can explicitly show that is a global symbol.

An automatic variable can be referred to only when the variable is in memory. Otherwise, specifying an automatic variable causes an error.

1.17.2 Referring to C/C++ Variables

C/C++ variables can be specified using the same descriptions as in the source program written in C/C++

■ Specifying C/C++ Variables

C/C++ variables can be specified using the same descriptions as in the source program. The address of C/C++ variables should be preceded by the ampersand symbol "&&". Some examples are shown in Table 1.17-1.

Table 1.17-1 Examples of Specifying Variables

Example of Variables		Example of Specifying Variables	Semantics
Regular Variable	int data:	data	Value of data
Pointer	char *p	*p	Value pointed to p
Array	char a[5]:	a[1]	Value of second element of a

Structure	struct stag{
	char c:
	int:
	};
	struct stag st;
	struct stag *stp:
		st.c
		stp->c
			Value of member c of st
			c the structure to which stp points

Union	union utag{ char c; int i; }uni:	unu.i	Value of member i of uni
Address of variable Reference type	int data; inti i;	&data	Address of data

class	int &ri = i;
	class X{
	static int i;
	}cls;
		ri
		cls.i
		x::i
			Same as i
			Value of member i of class X
			Same as cls.i

Member pointer
class
	int X::i;
	class X{
	short cs;
	}clo;
	short X::* ps = &X::cs;
	X* clp = &clo;
		clo.*ps
		clp->*ps
			Same as do.cs
			Same as clp->cs

■ Notes on C/C++ Symbols

The C/C++ compiler outputs symbol information with "_" prefixed to global symbols. For example, the symbol main outputs symbol information _main. However, SOFTUNE Workbench permits access using the symbol name described in the source to make program debugging easier.

Consequently, a symbol name described in C/C++ and a symbol name described in assembler, which should both be unique, may be identical.

In such a case, the symbol name in the Current Scope normally is preferred. To refer to a symbol name outside the Current Scope, specify the symbol with the module name.

If there are duplicated symbols outside the Current Scope, the symbol name searched first becomes valid. To refer to another one, specify the symbol with the module name.

1.18 I/O Operations

This section describes the I/O operations.

■ I/O Operations

The I/O window is opened when the [View] - [I/O] command is executed. The I/O registers value can be displayed in the I/O window.

For further details about modifying the I/O registers value, refer to the Operation Manual 3.17 I/O Window.

CHAPTER 2
DEPENDENCE FUNCTIONS

This chapter describes the functions depending on each debugger.

2.1 Simulator Debugger

2.2 Emulator Debugger

2.3 Monitor Debugger

2.4 Abortion of Program Execution (SIM, EML, MON)

2.5 Analyzing Program Execution (SIM, EML, MON)

2.1 Simulator Debugger

This section describes the functions of the simulator debugger.

■ Simulator Debugger

The simulator debugger (later referred as simulator) simulates the MPU operations (executing instructions, memory space, I/O ports, interrupts, reset, etc.) with software to evaluate a program.

It is used to evaluate an uncompleted system, the operation of single units, etc.

■ Simulation Range

The simulator simulates the MPU operations (instruction operations, memory space, interrupts, reset, low-power consumption mode, etc.) Peripheral I/Os, such as a timer, DMAC and serial I/O, other than the CPU core of the actual chip are not supported as peripheral resources. I/O space to which peripheral I/Os are connected is treated as memory space. There is a method for simulating interrupts like timer interrupts, and data input to memory like I/O ports. For details, see "2.1.3 I/O Port Simulation" and "2.1.4 Interrupt Simulation".

Instruction simulation

Memory simulation

I/O port simulation (Input port)

I/O port simulation (Output port)

Interrupt simulation

Reset simulation

Power-save consumption mode simulation

2.1.1 Instruction Simulation

This section describes the instruction simulation executed by SOFTUNE Workbench.

■ Instruction Simulation

This simulates the operations of all instructions supported by the FR-V Family. It also simulates the changes in memory and register values due to such instructions.

Program execution is aborted when a combined instruction is executed though execution is not possible because of an issue restriction.

2.1.2 Memory Simulation

This section describes the memory simulation executed by SOFTUNE Workbench.

■ Memory Simulation

The simulator must first secure memory space to simulate instructions because it simulates the memory space secured in the host machine memory.

- To secure the memory area, either use the [Setup] - [Memory Map] command, or the Set Map command in the Command window.
- Load the file output by the Linkage Editor (Load Module File) using either the [Debug] - [Load target file] command, or the LOAD/OBJECT command in the Command window.

■ Simulation Memory Space

Memory space access attributes can be specified byte-by-byte using the [Setup] - [Memory Map] command. The access attribute of unspecified memory space is Undefined.

■ Memory Area Access Attributes

Access attributes for memory area can be specified as shown in Table 2.1-1. A guarded access break occurs if access is attempted against such access attribute while executing a program. When access is made by a program command, such access is allowed regardless of the attribute, CODE, READ or WRITE. However, access to memory in an undefined area causes an error.

Table 2.1-1 Types of Access Attributes

Attribute	Semantics
CODE	Instruction execution enabled
READ	Data read enabled
WRITE	Data write enabled
undefined	Attribute undefined (access prohibited)

2.1.3 I/O Port Simulation

This section describes I/O port simulation executed by SOFTUNE Workbench.

■ I/O Port Simulation (Input Port)

There are two types of simulations in I/O port simulation: input port simulation, and output port simulation. Input port simulation has the following types:

- Whenever a program reads the specified port, data is input from the pre-defined data input source.
- Whenever the instruction execution cycle count exceeds the specified cycle count, data is input to the port.

To set an input port, use the [Setup] - [Debug Environment] - [I/O Port] command, or the Set Inport command in the Command window.

Up to 4096 port addresses can be specified for the input port. The data input source can be a file or a terminal (input from the terminal window). After reading the last data from the file, the data is read again from the beginning of the file. The data is read from the input data queue of the input terminal window when set port is read accessed if the terminal is specified.

A text file created by an ordinary text editor, or a binary file containing direct code can be used as the data input file. Text files are composed of numbers 0 to 9 and the letters of the alphabet A to F and cannot have delimiters or restore codes (CR codes). Errors will occur if other characters (spaces, commas, tabs, etc.) are included. When using a binary file, select the binary radio button in the input port dialog.

■ I/O Port Simulation (Output Port)

At output port simulation, whenever a program writes data to the specified port, writing is executed to the specified data output destination.

To set an output port, either use the [Setup] - [Debug Environment] - [I/O Port] command, or the Set Outport command in the Command window.

Up to 4096 port addresses can be set as output ports. Select either a file or terminal (Output Terminal window) as the data output destination.

A destination file must be either a text file that can be referred to by regular editors, or a binary file. To output a binary file, select the Binary radio button in the Output Port dialog.

2.1.4 Interrupt Simulation

This section describes interrupt simulation executed by SOFTUNE Workbench.

■ Interrupt Simulation

This simulates the MPU operation for an interrupt request. The correspondence between the cause of each interrupt and the trap type (TT) number is made by referring to the install file read at simulator start-up.

The following types can be used to allow an interrupt to occur.

- When the instruction is executed as many cycles as the specified cycle count while executing a program (executing execution commands), generate an interrupt corresponding to the specified interrupt number to reset the interrupt generating condition.
- Whenever the instruction executing cycle count exceeds the specified cycle, an interrupt continues to be generated.

The type of interrupt can be set using either the [Setup] - [Debug Environment] - [Interrupt] command, or the Set Interrupt command in the Command window. If an interrupt is masked by an interrupt-enabled flag when the interrupt generating condition is met, the interrupt is generated after canceling the mask. When an interrupt is generated while executing a program, an interrupt cause number is displayed on the Status Bar.

Furthermore, the simulator supports the MPU operation for interrupt requests for the following exception processing.

- Privileged instruction exception

  Executes privileged instruction when the register PSR.S is bit 0.
- Illegal instruction exception

  Executes instructions that have not been implemented.
- Floating-point decimal invalid exception

  Executes instruction accessing the register FR or the floating-point decimal instruction when the register PSR.EF = bit 0 and PSR.EM = bit 0.
- Media invalid exception

  Executes instruction accessing the register FR or the media instruction when the register PSR EM = bit 0.
- Memory address unsort exception

  Accesses the unsort executable address using the load/store instruction.

  Accesses the unsort memory address using the control transmission instruction.
- Register exception

  Specifies the address that is not allowed for specifying register in the instruction field. Un-implemented register access.
- Floating-point decimal exception

  IEEE754 exception occurred because of the execution of the floating-point decimal instruction.

  Execution of the unimplemented floating-point decimal instruction.

  Accesses unimplemented register using the floating-point decimal instruction.
- Media exception

  Overflow occurred because of the execution of the media instruction.

  Accesses the unimplemented register using the media instruction.

  Accesses the unsort executable address using the media instruction.

- Division exception
  Zero division occurred when executing a division instruction.
  Overflow occurred because of execution of the division instruction.
- Commit exception
  COMMIT instruction execution when detecting an exception using the Non-exception instruction.

2.1.5 Reset Simulation

This section describes the reset simulation executed by SOFTUNE Workbench.

■ Reset Simulation

The simulator simulates the MPU operation when a reset signal is input to the MPU by using either the [Debug] - [Reset of MPU] command, or the Reset command in the Command window. This initializes registers.

2.1.6 Low-Power Consumption Mode Simulation

This section describes the low-power consumption mode simulation executed by SOFTUNE Workbench.

■ Low-Power Consumption Mode Simulation

The MPU enters the low-power consumption mode in accordance with the MPU instruction operation (Write to PDM field of hardware status register). Once in the PLL operation mode or PLL stop mode, a message ("sleep" for PLL operation mode, "stop" for PLL stop mode) is displayed on the Status Bar. The loop keeps running until either an interrupt request is generated, or the [Run] - [Abort] command is executed. Each cycle of the loop increments the count by 1. During this period, I/O port processing can be operated.

2.2 Emulator Debugger

This section describes the functions of the emulator debugger.

■ Emulator Debugger

The emulator debugger (later referred as emulator) is software to evaluate a program by controlling an ICE from a host via a communications line (RS-232C, USB).

Before using this emulator, the ICE must be initialized.

For further details, refer to the Operation Manual Appendix B Download Monitor Program.

2.2.1 Notes on Executing Program

There are several points to note about program execution commands in the emulator.

■ Restrictions when Suspended by Software Break

When there is a software break at the current PC location, if either the [Run] - [Go] command or the Go command is executed, the emulator performs one execution step internally, and then executes the program in batch processing.

2.2.2 Cache Control

This section describes cache control in the emulator debugger.

■ Cache Control

The FR-V has and holds the instruction cache and data cache separately. When a program using cache is executed, the following executions may cause damage to the coherency between cache and memory.

- When rewriting codes using a memory operation command or file load
- When memory data is changed in other than the debug CPU

For that reason, the debugger supports a function of matching data contents between memory and cache.

The debugger has the following three commands.

- Flush data cache (reflects the data cache contents to the memory)
- Invalidation of data cache (discards the data cache contents)
- Invalidation of instruction cache (discards the instruction cache contents)

When rewriting to the memory via the debugger, data access changes the memory contents. For this reason, the changed contents may be reflected only to the data cache, and data contents will not match between data cache and memory. In such cases, the "flush of data cache" command enables reflection of the data cache contents to the memory.

If these changes (such as one line assembly) are performed in the code region, the changed contents are not reflected to the instruction cache. When reflecting the changed contents at program execution the user must flush the data cache, and invalidate the instruction cache.

Follow the procedure below.

1) Flush the data cache.
2) Invalidate the instruction cache.

For details on cache operations and settings, refer to Sections 4.6.4 Cache Control; and 4.7.2.3 Environment Setting Dialog in the SOFTUNE Workbench Operation Manual, and to sections 1.27 Set Cache to 1.30 Invalidate Cache in the SOFTUNE Workbench Command Reference Manual.

■ Executing commands

Use GUI or a command to execute commands.

- GUI

  Select [Debug] - [Cache Control].
- command

  FLUSH CACHE
  INVALIDATE CACHE

■ Automatic Execution of Instruction Cache Invalidation

The debugger has the function of automatically executing of the invalidation instruction cache.

Use GUI or a command to set it.

- GUI

  Select the cache tab in the debug environment setting dialog box opened using the [Environment] - [Debugging Environment] commands.

- command

  SET CACHE

2.2.3 MMU Setting

This section describes MMU setting control in the emulator debugger.

■ MMU Setting

Specifies whether to enable MMU setting or not when the program stop, in the chip with MMU.

Please open the "Setup debug environment" dialog by [Setup] - [Debug Environment] command and clear "Enable MMU functions while break" check box in the MMU tab, if you want to write data in write-protected area with MMU.

2.2.4 Command Execution while Executing Program

This section describes command execution while executing a program in the emulator.

■ Command Execution while Executing Program

When executing a program using the [Run] - [Go] command, the Status Bar displays "Execute" to show that the program is running.

Certain commands can be executed in this circumstances (they vary with the type of debugger).

The execution procedures are the same, but some commands cannot be executed and some can be executed but are subject to restrictions.

To forcibly terminate the program, use the [Run] - [Abort] command.

Note that in the emulator debugger, memory Read/Write is re-executed while executing a program after permitting the MPU to break once for access.

2.3 Monitor Debugger

This section describes the functions of the monitor debugger.

■ Monitor Debugger

The monitor debugger performs debugging by putting the target monitor program for debugging into the target system and by communicating with the host.

Before using this debugger, the target monitor program must be ported to the target hardware.

2.3.1 Resources Used by Monitor Program

The monitor program of the monitor debugger uses the I/O resources listed below. The target hardware must have these resources available for the monitor program.

■ Required Resources

The following resources are required to build the monitor program into the target hardware.

Table 2.3-1 Required Resources

1	UART	Required	For communication with host computer 4800/9600/19200/38400/56000/57600/115200/128000/256000 baud
2	Monitor ROM	Required	44 KB required (For further details, see Link Map file under Sample program.)
3	Work RAM	Required	5 KB required (For further details, see Link Map file under Sample program.)
4	External Interrupt Switch	Optional	Used for suspending program forcibly. If not implemented forced termination only can be performed by reset, etc.
5	Timer	Optional	Used by SET TIMER/SHOW TIMER. Requires 32-bit timer in 1 us.

2.3.2 Cache Control

This section describes cache control in the monitor debugger.

■ Cache Control

The FR-V has and holds the instruction cache and data cache separately. When a program using cache is executed, the following executions may cause damage to the coherency between cache and memory.

- When rewriting codes using a memory operation command or file load
- When memory data is changed in other than the debug CPU

For that reason, the debugger supports a function of matching data contents between memory and cache.

The debugger has the following three commands.

- Flush data cache (reflects the data cache contents to the memory)
- Invalidation of data cache (discards the data cache contents)
- Invalidation of instruction cache (discards the instruction cache contents)

When rewriting to the memory via the debugger, data access changes the memory contents. For this reason, the changed contents may be reflected only to the data cache, and data contents will not match between data cache and memory. In such cases, the "flush of data cache" command enables reflection of the data cache contents to the memory.

If these changes (such as one line assembly) are performed in the code region, the changed contents are not reflected to the instruction cache. When reflecting the changed contents at program execution the user must flush the data cache, and invalidate the instruction cache.

Follow the procedure below.

1) Flush the data cache.
2) Invalidate the instruction cache.

For details on cache operations and settings, refer to Sections 4.6.4 Cache Control; and 4.7.2.3 Environment Setting Dialog in the SOFTUNE Workbench Operation Manual, and to sections 1.27 Set Cache to 1.30 Invalidate Cache in the SOFTUNE Workbench Command Reference Manual.

■ Executing Commands

Use GUI or a command to execute commands.

- GUI

  Select [Debug] - [Cache Control].
- command

  FLUSH CACHE
  INVALIDATE CACHE

■ Automatic Execution of Instruction Cache Invalidation

The debugger has the function of automatically executing of the invalidation instruction cache.

Use GUI or a command to set it.

- GUI

  Select the cache tab in the debug environment setting dialog box opened using the [Environment] - [Debugging Environment] commands.

- command

  SET CACHE

2.3.3 MMU Setting

This section describes MMU setting control in the monitor debugger.

■ MMU Setting

Specifies whether to enable MMU setting or not when the program stop, in the chip with MMU.

Please open the "Setup debug environment" dialog by [Setup] - [Debug Environment] command and clear "Enable MMU functions while break" check box in the MMU tab, if you want to write data in write-protected area with MMU.

2.3.4 Notes on Executing Program

There are several points to note about program execution commands in the monitor debugger.

■ Restrictions when Suspended by Software Break

When there is a software break at the current PC location, if either the [Run] - [Go] command or the Go command is executed, the emulator performs one execution step internally, and then executes the program in batch processing.

2.4 Abortion of Program Execution (SIM, EML, MON)

When program execution is suspended, the address where the break occurred and the break factor are displayed.

■ Abortion of Program Execution

When program execution is suspended, the address where the break occurred and the break factor are displayed.

In the emulator debugger, the following factor can suspend program execution.

- Software Breaks
- Hardware Breaks
- External Trigger Breaks
- Data Break Points
- Forced Break
- Breaks caused by detection of the CPU stopped state

In the simulator debugger, the following factors can suspend program execution.

- Break Points
- Data Break Points
- Guarded Access Breaks
- Forced Break
- Break by Issue Restriction
- Break by Conflict

In the monitor debugger, the following factors can suspend program execution.

- Software Breaks
- Hardware Break
- Data Break Points

2.4.1 Software Breaks (EML, MON)

A software break is a function to make a break by executing an instruction embedded in memory. The break occurs before executing the instruction at the specified address.

■ Software Breaks

With the emulator, you can set 4096 points for the software break points. With the monitor debugger, you can set 20 points for the software break points. See 2.3.1 Resources Used by Monitor Program.

Software breaks can be controlled by one of the following:

- [Run] - [Breakpoints] - [Code] command
- Setting break points in Source window
- Setting break points in Disassemble window
- Set Break/Soft command

When a break occurs due to a software break, the following message is displayed in the Status Bar.

Break at Address breakpoint

■ Notes on Software Breaks

There are three points to note when using software break point.

- Software breaks cannot be set in read only areas, such as ROM. If an attempt is made to do so, a verify error occurs at program startup (continuous execution in batch processing, step execution, etc.).
- Always set a software break at the parallel instruction starting address. Setting a software break point in the middle of an instruction, may cause a software error.
- The current line of the source in the source window is offset and displayed in order to clearly show the next instruction executed in the parallel instruction when the software break is set at the starting address of the parallel instruction and the program aborts the execution because of this reason.

2.4.2 Hardware Breaks (EML, MON)

A hardware break is a break point achieved by monitoring the chip bus using hardware. A hardware break suspends the instruction operation immediately before executing the specified address instruction.

■ Hardware Breaks

A maximum of three hardware break points can be set.

Instruction breaks can be controlled by either of the following:

- [Run] - [Breakpoints] - [Code] command
- Set Break/Hard command

When a break occurs due to a hardware break, the following message is displayed on the Status Bar.

Break at Address by hardware breakpoint

■ Notes on Hardware Breaks

There are several points to note when using hardware breaks point.

- Always include the instruction starting address in the hardware break point within the specified range. Otherwise, the break may not occur.
- Set the hardware break in the starting address of the parallel instruction using the following methods.

Set using the SET BREAK command

Set from the break point dialog

Set from the disassemble window

The current line of the source in the source window is offset and displayed in order to clearly show the instruction executed next in the parallel instruction when the program execution is aborted because of this reason.

2.4.3 External Trigger Break (EML)

An external trigger break is a function to suspend program execution when an external signal is input from the emulator TRIG pin.

■ External Trigger Break

You can abort the execution of the program when inputting an external signal from the TRIG pin on the front of the emulator.

When a break occurs due to an external trigger break, the following message is displayed on the Status Bar.

Break at Address by external trigger break

2.4.4 Break Points (SIM)

A break point is a program memory location where the simulator suspends the program each time the point is reached while the program is executing (while executing execution commands). Normally a break point is set in the program space (the space where the CODE attribute is specified).

■ Break Points

Break points can be controlled using the [Run] - [Breakpoints] - [Code] command. When the program reaches a break point (immediately before executing the instruction at the memory location), the simulator executes the following processes:

1. Suspends program execution (before executing instruction)
2. Checks count of arrival time. If the count of arrival time at the specified break point has not yet been reached, the simulator resumes the program execution. If the count of arrival time has been reached, the simulator proceeds to step 3.
3. Displays memory location where execution suspended on Status Bar.
4. Break points set using the [Run] - [Breakpoints] - [Code] command, remain valid until canceled or temporarily reset.

Up to 65535 break points can be set. Break points cause the program to suspend instruction operation just before executing the instruction at the specified address. In addition to using the [Run] - [Breakpoints] - [Code] command, break points can be set as follows:

- Setting break points in Source window
- Setting break points in Disassemble window
- Set Break command

The following message is displayed on the Status Bar when a break occurs due to a break point.

Break at Address by breakpoint

■ Notes on Simulator Break Point

There are several points to note when using simulator break point.

- Set the break point in the starting address of the parallel instruction using the following methods.

Set using the SET BREAK command

Set from the break point dialog

Set from the disassemble window

The current line of the source in the source window is offset and displayed in order to clearly show the instruction executed next in the parallel instruction when the program execution is aborted because of this reason.

2.4.5 Data Break Points (SIM, EML, MON)

A data break point is the memory location where a program execution is suspended when data access (Read/Write) is performed while executing a program (while executing execution commands).

■ Data Break Points

The simulator/emulator/monitor debugger monitors whether the specified data access is made to a data break point while a program is executing; if such data access is made, it suspends the program. Data break points can be controlled using either the [Run] - [Breakpoints] - [Data] command, or the Set DataBreak command in the Command window. When specifying a data break point with a symbol, the starting address of that symbol becomes the data break point. You can set a maximum of 65535 data break points with the simulator and a maximum of 4 with the emulator and monitor debugger.

When a break occurs due to a data break point, the following message is displayed.

Break at Address by DataBreak at Access Address

■ Writing to Data Break Point

When data is written to a data break point, the simulator executes the following processes:

1. Suspends program execution after completing instruction execution
2. This checks whether the position of the bit that specified 1 with the mask data and the bit value that was specified by the data match for the data writing to. With the simulator, it checks the size of the data writing to. If conditions are met, the simulator proceeds to step 3.
3. Checks access count. If the access count has not yet reached the count for the specified data break point, the simulator resumes the program execution. If the count has been reached, the simulator proceeds to step 4.
4. If program execution is suspended by reaching access count, on Status Bar, displays memory location of data break point and of instruction writing to it.
5. Displays memory location executed next

■ Reading from Data Break Point

When reading from a data break point, the simulator executes the following processes:

1. Suspends program execution after completing execution of the instruction
2. This checks whether the position of the bit that specified 1 with the mask data and the bit value that was specified by the data match for the data writing to. With the simulator, it checks the size of the data writing to. If conditions are met, the simulator proceeds to step 3.
3. Checks access count. If the access count has not yet reached the count for the specified data break point, the simulator resumes the program execution. If the count has been reached, the simulator proceeds to step 4.
4. If program execution is suspended by reaching count, on Status Bar, displays memory location of data break point and of instruction reading from it
5. Displays memory location executed next

■ Notes on Using Data Breaks

There are two points to note when using data break points as follows:

- If an automatic variable within a C function is specified, a data break is set at the address where the automatic variable is held. Therefore, the data break remains valid even after the specified automatic variable becomes invalid (after exiting function), causing a break due to unexpected access.
- To allow access to a variable in C to cause a break, specify the variable address by putting an ampersand symbol "&&" immediately before the variable symbol.

2.4.6 Guarded Access Breaks (SIM)

A guarded access break suspends a executing program when accessing in violation of the access attribute set by using the [Setup] - [Memory Map] command, and accessing a guarded area (access-disabled area in undefined area).

■ Guarded Access Breaks

Guarded access breaks are as follows:

- Code Guarded
  An instruction has been executed for an area having no code attribute.
- Read Guarded
  A read has been attempted from the area having no read attribute.
- Write Guarded
  A write has been attempted to an area having no write attribute.

If a guarded access occurs while executing a program, the following message is displayed on the Status Bar and the program execution suspended.

Break at Address by guarded access {code/read/write} at Access Address

2.4.7 Forced Break (SIM, EML)

A program execution can be forcibly suspended by using the [Run] - [Abort] command.

■ Forced Break

When a break occurs due to a forced break, the following message is displayed on the Status Bar.

Break at Address by command abort request

■ Forced Break in Low-Power Consumption Mode

A forced break is not allowed in the emulator debugger while the MPU is in the low-power consumption mode. When a forced break is requested by the [Run] - [Abort] command while executing a program, the command is disregarded if the MPU is in the low-power consumption mode. If a break must occur, then reset the factor at user system side, or reset the factor by using the [Run] - [Reset of MPU] command, after inputting the [Run] - [Abort] command.

When the MPU enters the low-power consumption mode while executing, the status is displayed on the Status Bar.

2.4.8 Breaks by Issue Restrictions (SIM)

Program execution is suspended when a combined instruction that was not allowed was executed in 1 parallel instruction.

■ Breaks by Issue Restrictions

With the simulator debugger, program execution is suspended when a combined instruction that was not allowed is executed in 1 parallel instruction. The following message is displayed when a break occurs because of the issue restriction.

Break at address by violation to combine instructions

With the simulator debugger, program execution is suspended when the instruction is executed regardless of whether it was an instruction that cannot be issued in the slot or 1 parallel instruction. The following message is displayed when a break occurs because of the issue restriction.

Break at address by slot issue violation

Refer to the LSI specification for issue restrictions.

2.4.9 Breaks by Conflicting Writing (SIM)

The program execution is suspended when a plurality of instructions that write access the same memory or the register are executed in 1 parallel instruction.

■ Breaks by Conflict

With the simulator debugger, program execution is suspended when a plurality of instructions that write access the same memory or the register are executed in 1 parallel instruction. The following message is displayed when a break occurs because of the conflicting writing.

Break at address by resource write-write confliction

2.4.10 Breaks Caused by Detection of the CPU Stopped State (EML)

A break caused by detection of the CPU stopped state means a break caused when a hold inhibit program interrupt factor or a software interrupt factor is detected when the system is in the interrupt inhibit state.

■ Breaks Caused by Detection of the CPU Stopped State

When using a break caused by detection of the CPU stopped state, enable the CPU-stopped-state detection function by using the following commands: [Environment] - [Set the Debugging Environment] - [Debugging Environment]. The default value at the time of debugger activation is enabled.

When a break has occurred due to detection of the CPU stopped state, the following message is displayed in the status bar:

Break at address by EIT (interrupt factor TT: number)

■ A Note on Breaks Caused by Detection of the CPU Stopped State

Disable the CPU-stopped-state detection function when performing the following, for instance: debugging a utility that uses the mechanism that saves the factor for the stopped state, or debugging the hardware that responds to the stopped state.

2.5 Analyzing Program Execution (SIM, EML, MON)

You can trace the execution history to analyze the program.

■ Analyzing Program Execution

The following types are available for analyzing program execution.

- Trace
- Measuring Execution Time

2.5.1 Trace (SIM, EML)

While executing a program, execution address information can be sampled and recorded in the trace buffer. This function is called trace.

■ Trace

The program execution history can be deep-analyzed using the data recorded by the trace function. This function is only available in the simulator debugger and the emulator debugger.

The trace buffer has a ring structure, so when the trace buffer becomes full, it automatically returns to the buffer start address to overwrite existing data.

Trace Data

Tracing Function

Setting Trace

Displaying Trace Data

Displaying Format of Trace Data

Searching Trace Data

Saving Trace Data

Clearing Trace Data

Notes on Use of Tracing Function

2.5.2 Trace Data (SIM, EML)

Data sampled and recorded by tracing is called trace data. The recording format of trace data varies with each debugger.

■ Trace Data

You can sample the following sizes using the emulator debugger.

- Full Trace Mode: 8 branches prior to suspending execution
- Trace trigger Mode: 4 branches before and after passing the first trigger

The following data is sampled.

- Address (32 Bits)
- Only Instruction Execution

The simulator debugger can sample trace data by 1,000 frames.

2.5.3 Tracing Function (SIM, EML)

The status of the program execution is trace measured during the period from starting execution to the end of the execution of the program. With the emulator, you can trace measure 4 branches before and after the execution of the program first passes the specified address (trace trigger).

■ Tracing Function

If the trace function is enabled, data is always sampled while executing the execution command and that is stored in the trace buffer.

With the emulator, information for 8 branches immediately before the suspension are recorded in the trace buffer, when the program execution is suspended. Also, there is a function for starting the trace measurement while the following program is executed.

- When the trace sampling mode is switched to trace trigger mode, this trace measures the 4 branches before and after the execution of the program first passes the address (trace trigger) specified by the trace window short cut menu [Setup] - [Trace Trigger].

The program execution is suspended by the break factor such as break point and tracing stops.

When the trace buffer is full with simulator debugger, you can break the program. This break is called a trace buffer full break.

■ Frame Number

The sampled trace data is numbered in frame units. This number is called the frame number.

When in Full Trace Mode, specify from which position to display from the trace buffer to perform using the frame number. A 0 accompanies the trace data that was sampled last and a negative number accompanies the trace data sampled up to the position where the trigger occurred.

When in the Trigger Trace Mode, the trace data that passed through the address setting the trigger trace becomes 0 and positive and negative numbers accompany the preceding and anteceding trace data.

2.5.4 Setting Trace (SIM, EML)

You must set the following 3 items to perform a trace. After that, trace data will be sampled with the execution of the program. You can set this from the command window.

■ Setting Trace

1. Enable the trace function.
   This is done by [Setup] - [Trace] in the trace window shortcut menu. This program will startup and will be enabled.
2. Set the trace mode. (Only Emulator Debugger)
   This is done by [Setup] - [Trace Trigger] in the trace window shortcut menu.
3. Set the trace buffer full break. (Only Simulator Debugger)
   When the trace buffer is full, you can make a break. This is done using the setting dialog boxes of the trace window shortcut menu [Setup] - [Trace].
   When starting up this program, it is setup for no breaks.

2.5.5 Displaying Trace Data (SIM, EML)

Data recorded in the trace buffer can be displayed.

■ Displaying Trace Data

The trace window displays how much trace data is stored in the trace buffer. Also, you can use the Show Trace command from the command window.

With the emulator debugger, it shows the code information analyzed from the branch information as the trace data.

2.5.6 Display Format of Trace Data (SIM, EML)

There are display formats for displaying trace buffer data:

■ Display Format of Trace Data

- Display Only Instruction Execution (Specify Instruction)
- Display by Unit of Source Lines (Specify Source)

■ Display Only Instruction Execution

In this mode, the instruction execution is displayed in disassembly units.

■ Display by Unit of Source Lines

This mode only displays source lines.

2.5.7 Searching Trace Data (SIM, EML)

Trace data can be searched to find where data to be displayed is stored in the trace buffer.

■ Searching Trace Data

Specify the search by code fetch address information. In addition, the masking function can be used with address.

Click the Search button in the Trace window to use this function.

2.5.8 Saving Trace Data (SIM, EML)

The debugger has function of saving trace data.

■ Saving Trace Data

Save the trace data to the specified file.

For details on operations, refer to Sections 3.14 Trace Window, and 4.4.8 Trace in the SOFTUNE Workbench Operation Manual; and Section 4.11 Shoe Trace in the SOFTUNE Workbench Command Reference Manual.

2.5.9 Clearing Trace Data (SIM, EML)

To clear trace data, use the following command.

■ Clearing Trace Data

Execute the [Clear] command from the short-cut menu in the Trace window to clear trace data.

2.5.10 Notes on Use of Tracing Function (SIM, EML)

There are several points to note when displaying or searching trace data.

■ Notes on Trace Function

When the emulator debugger is in use, tracing is enabled by the following:

- Output address information at fetching branch instruction
- Execution Start
- When executing branching conditions, the CCCR changes from the previous trace information.

For these reasons, note the following points when displaying and searching trace data

- When displaying disassembly, data is read from memory and processed. Therefore, the displayed data may not be correct if the instruction is rewritten after code fetching.

2.5.11 Measuring Execution Cycle Counts (EML)

The program instruction execution cycle counts can be displayed by using either the [Analyze] - [Time Measurement] command, or the Show Timer command in the Command window.

■ Measuring Execution Cycle Counts

Measures program execution cycle counts.

The measurement result can be displayed as two time values: the execution cycle counts of the preceding program, and the total execution cycle counts of the programs (total execution cycle counts before preceding program plus execution cycle counts of preceding program). Measurement is performed each time a program is executed.

Clear the measured values using the Clear Timer command.

Note:

Execution cycle counts are measured in several tens of cycles at one execution. When measuring execution cycles, set for consecutive executions of many instructions to decrease the efficacy of errors.

2.5.12 Measuring Execution Time (SIM)

The instruction cycle count and step count of a program can be displayed by using either the [Analyze] - [Time Measurement] command, or the Show Timer command in the Command window.

■ Measuring Execution Time

Measures program execution cycle count and step count.

The measurement result can be displayed as two time values: the execution time of the preceding program, and the total execution time of the programs (total execution time before preceding program plus execution time of preceding program). Measurement is performed each time a program is executed.

To display the execution cycle count, use the [Analyze] - [Time Measurement] command or the Show Timer command in the Command widow. Clear the measured values using the Clear Timer command.

The counters for the instruction execution cycle count and program step count are both H'1 to H'FFFFFFFF.

The count of the instruction execution cycle is calculated based on the basic cycle count of each instruction described in the Programming Manual.

Since the chip internal pipeline processing and cache operation are not simulated, such counts may be erroneous and different from those of the actual chip.

2.5.13 Measuring Execution Time (MON)

The program instruction execution time can be displayed by using either the [Analyze] - [Time Measurement] command, or the Show Timer command in the Command window.

■ Measuring Execution Time

Measures program execution time.

The measurement result can be displayed as two time values: the execution time of the preceding program, and the total execution time of the programs (total execution time before preceding program plus execution time of preceding program). Measurement is performed each time a program is executed.

To display the execution cycle count, use either the [Analyze] - [Time Measurement] command, or the Show Timer command in the Command window. Clear the measured values using the Clear Timer command.

Measurement is in 1 μs units. The maximum measurement time is about 70 minutes. The measurement result may have a ± 10 μs error.

2.5.14 Performance Measurement (EML)

The execute cycle count; pass-through count, and cache hit rate between two points can be measured. Real time measurements can be repeatedly made while the program is being executed, and after completion of the measurements, data is summed up and displayed. Using this performance measurement function, you can measure the performance of the program.

■ Performance Measurement Function

The performance measurement function can measure the execute cycle count, pass-through count, and cache hit rate between the specified two points. Using this function, you can measure the performance of the program to be debugged.

This function is able to use when using the chip that has PA-function only.

■ Performance Measurement Function

The performance measurement procedure is as shown below.

- Setting of the performance measurement range: SET PERFORMANCE
- Performance measurement: GO, STEP, CALL
- Display of the measured result: SHOW PERFORMACE

2.5.14.1 Performance Measurement Procedure

The performance measurement procedure is as shown below.
- Setting of the performance measurement range: SET PERFORMANCE
- Performance measurement: GO, STEP, CALL
- Display of the measured result: SHOW PERFORMACE

■ Setting of the Performance Measurement Range

The performance measurement range is set using the SET PERFORMANCE command.

The number of the setting sections changes with MPU kinds.

Example:

```
>SET PERFORMANCE H'0000FF00, H'0000FF0C
```

■ Performance Measurement

When preparations for performance measurement are made, the program is executed.

When the program is executed using the GO, STEP, CALL commands, performance measurement is made.

■ Display of the Measured Result

Measured data (measured results) is displayed using the SHOW PERFORMACE command. The following measured results can be displayed:

- Total execute cycle count, and the section's average execute cycle count
- Pass-through count
- Instruction cache hit rate, instruction cache hit count, and instruction cache miss count
- Data cache (read) hit rate, data cache (read) hit count, and data cache (read) miss count
- Data cache (write) hit rate, data cache (write) hit count, and data cache (write) miss count

```
>SHOW PERFORMANCE
Measurement:      Enable

Start Address:    00002764
End   Address:    0000283C
Interrupt Suspend: OFF

Executed:         2617[cycle] ave.
Total Cycle:      49733
Pass Count:       19
Cache
Code Fetch:       86.47% Hit
Hit:              5375
Miss:             841
Data Read:        89.43% Hit
Hit:              2090
```

Miss:	247
Data Write:	23.75% Hit
Hit:	388
Miss:	1246

CHAPTER 3
MULTI-CORE DEVELOPMENT ENVIRONMENT

In this chapter, function for development environment for multi-core is explained.

3.1 Development Environment for Multi-core
3.2 Object Programming Model
3.3 Target File
3.4 Multi-core Project
3.5 Session
3.6 Debugging Multi-core
3.7 Duplication of Workbench
3.8 Command
3.9 Cautions for Multi-core Debugging

3.1 Development Environment for Multi-core

This section explains about the function of development environment for 1 chip type multi-core that mounts the number of core with FR-V architecture.

■ Features

SOFTUNE Workbench has following features as a development environment for multi-core.

- Project management compliant to multi-core
- Enable to debug a number of cores at the time.

■ Project Management Compliant to Multi-core

Conventional project management has targeted only on a single core. For a multi cores compliant-debugger, a master project is used for overall management and slave project to control information depending on core.

■ Enable to Debug a Number of Cores at the Time

There are two methods for implementing debugging.

- A method to control all cores with one SOFTUNE Workbench
- A method to control a number of cores with few SOFTUNE Workbench

■ Extend the Concept of Session to Multi Cores

SOFTUNE Workbench controls information for debugger per core. The unit of this controlled information is called session.

3.2 Object Programming Model

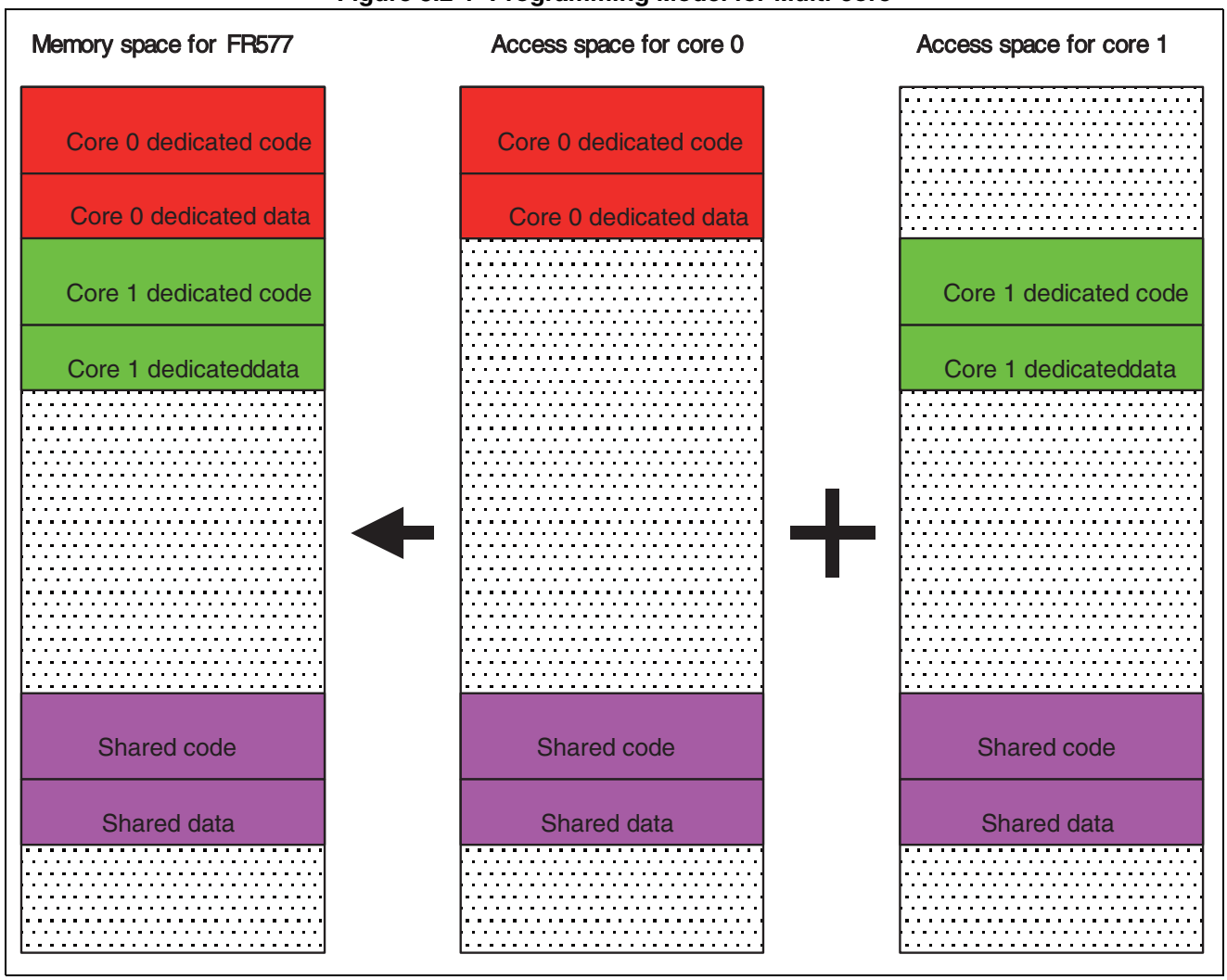
This section explains object-programming model at multi-core.

■ Object-programming Model

SOFTUNE Workbench supports following programming model as a development environment for multi-core. In the same memory space, dedicated code per core, shared code between data and core, and data are allocated.

However, it must be careful for not making the duplication of dedicated code/ shared code with data/ and data allocation. Refer to "3.4.4 Shared Project" for details .

Figure 3.2-1 Programming Model for Multi-core



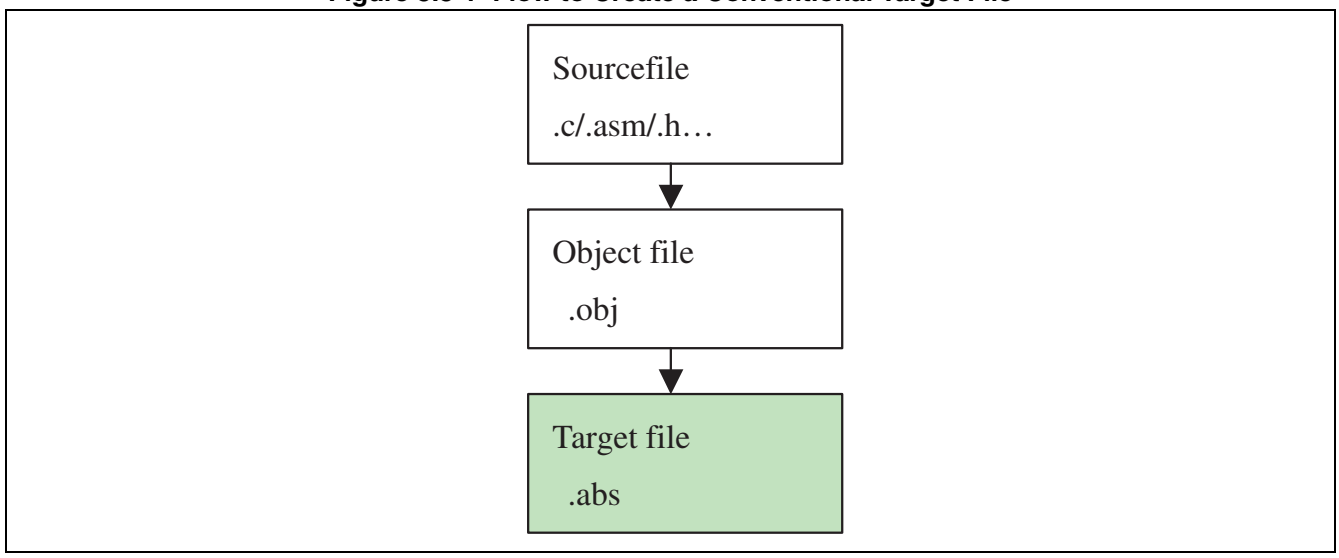
3.3 Target File

This section explains about a target file.

A target file is an absolute format that was created based on source file to be controlled by a project.

A conventional target file composes of one target program by compiling and building the number of source files.

Figure 3.3-1 Flow to Create a Conventional Target File



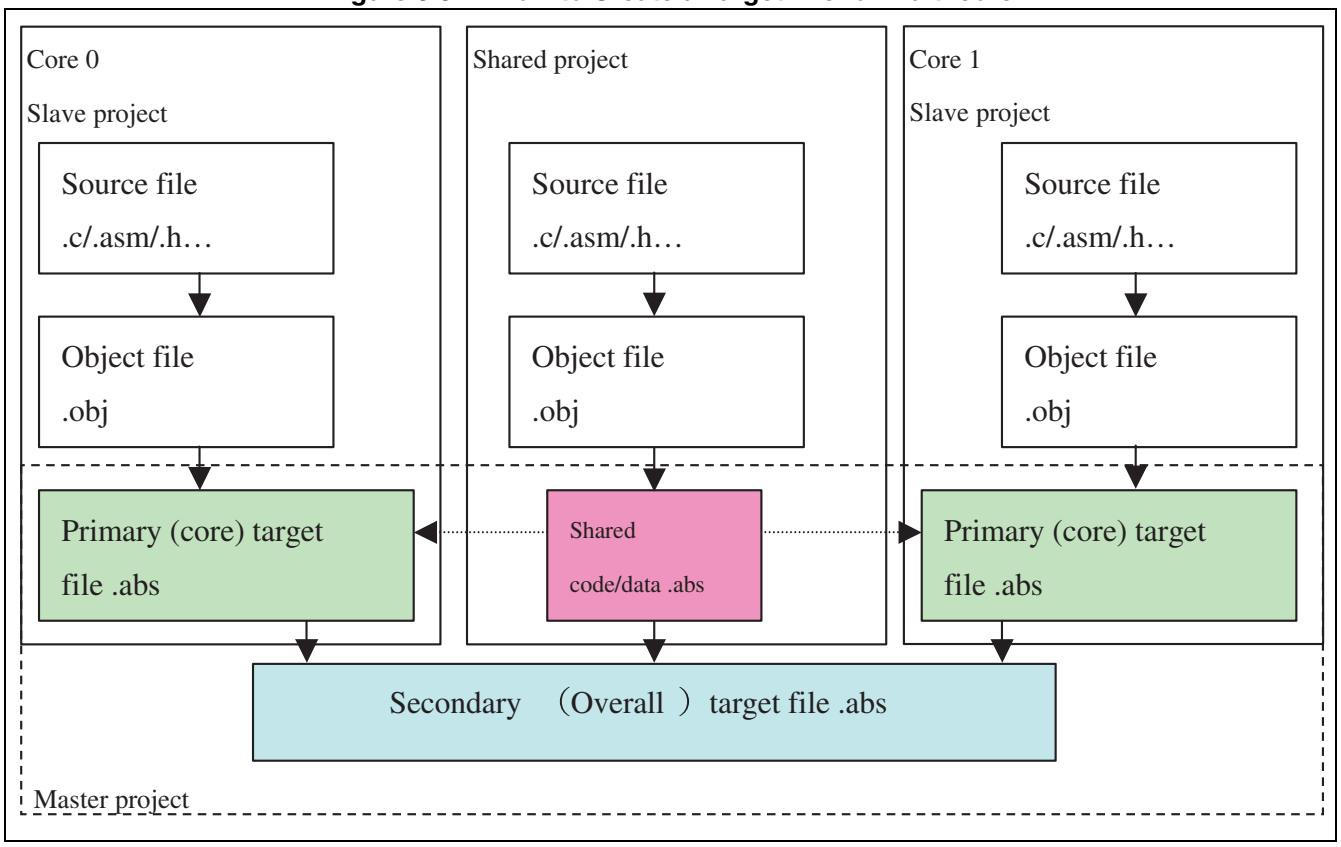
3.3.1 Target File at Multi-core Environment

This section explains about a target file used in multi-core environment.

For a target file under multi-core environment, primary target file will be created for each code from source file in project.

After primary target core is created for each code accordingly to the number of core, secondary target file will be created as a target file in whole system.

Figure 3.3-2 Flow to Create a Target File for Multi-core



At this point, primary target file is called core target file, and secondary target file is called overall target file.

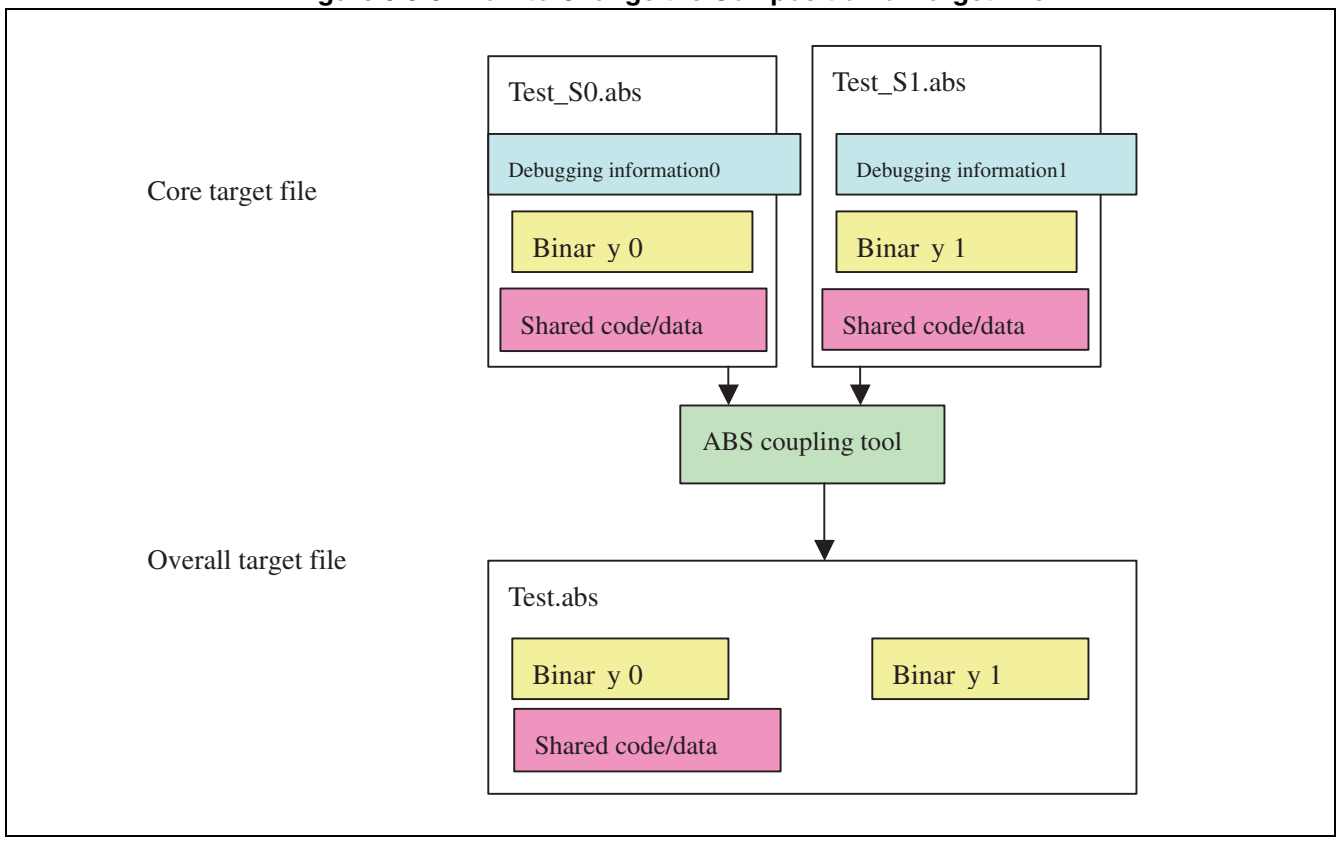
3.3.2 Composition of a Target File

This section explains about the flow to change a composition of a target file.

Target file for master project is the combined binary information (except debugging information) in primary target file for each core. This is combined by ABS Concatenation tool.

If there are shared code/data in target of each core, they become as one shared code/data after binding to ABS.

Figure 3.3-3 Flow to Change the Composition of Target File



3.4 Multi-core Project

This section explains about multi core project.

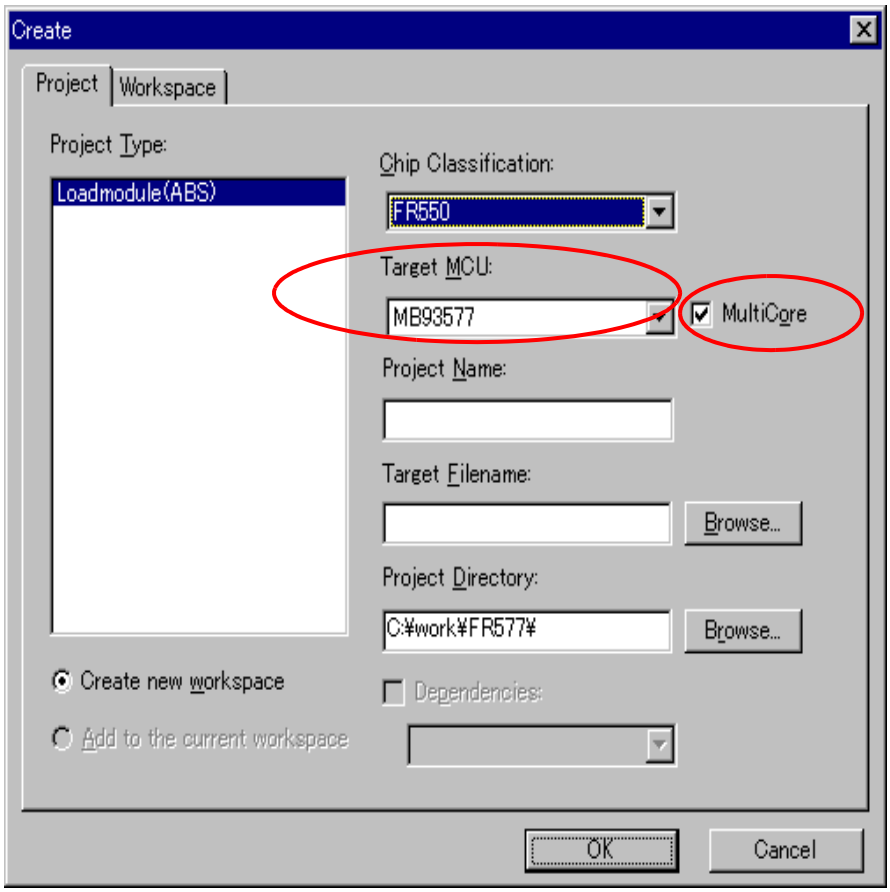
■ What is Multi Core Project?

Project for multi core is composed of master project and slave project.

■ Create

By choosing the type of multi core from target MCU for creating a project, checkbox for multi core control will be appeared. By placing a checkmark on the box, it makes possible to create multi core project.

Figure 3.4-1 Create New Project for Multi Core



■ Procedure for Creating New Multi-core Project

(1) Open [New] dialog from Menu [File]-[Create]

(2) Choose MB number of multi core CPU from [Target MCU]

(3) Place a checkmark on checkbox [Multi-core control]

Project created under these conditions is for multi core (master, slave styles), and the project enables to implement debugging for each core.

Project type for slave project, which is chosen by master project, will be reflected as default.

By removing the checkmark from [multi core control] and creating a project, conventional project for single core will be created.

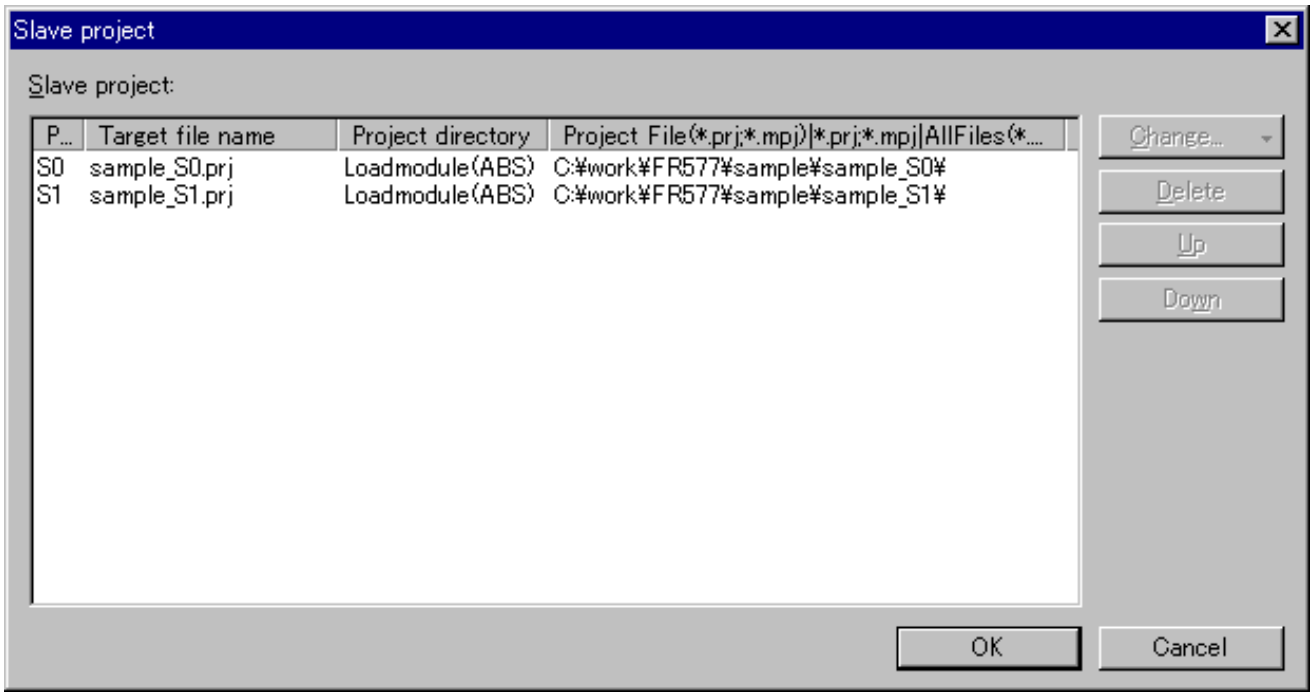
If a project type creates project with relative format (REL) or library format (LIB), remove a checkmark from [multi-core control] and create it as a project for single core.

Multi-core control	Project type
ON	Absolute format(ABS) REALOS (ABS)
OFF	Absolute format(ABS) REALOS(ABS) Relative format(REL) Library format(LIB) Share(ABS)

■ Composition of Multi Core Project

The name of master project and a project, which is specified when the project is created, are the same. The name of file will be generated as "the name of master project _S%d" in default for slave project. %d includes the core number. The name of slave project can be changed in dialog [Slave project list].

Figure 3.4-2 Slave Project List



Confirmation or modification of a slave project to be created can be done in dialog [Slave project list].

However, changing "Location" and "Project type" for project is not possible if a project is already created. Moreover, exist project can also add to slave project.

Slave project will be created accordingly to the number and order of core.

Dialog [Slave project list] can be called not only when new master project is created but also can be called from short-cut menu [Slave project] of master project on window.

After creating master project, registering is possible for slave project of which number exceeds the number of cores. However, ID of slave project, of which number exceeds cores in MCU, is not a subject for Make and Debugging.

Even though the number of project is less than core, registry can be implemented by deleting slave project. However, it is required to have at least one slave project.

■ Project Administrative Information for Controlling Multi-core

By crating multi-core controllable project, project will be created like configuration shown as in following Fig.

Explanation of the project specification extended for multi core is given here.

Figure 3.4-3 Example of Multi Core Project

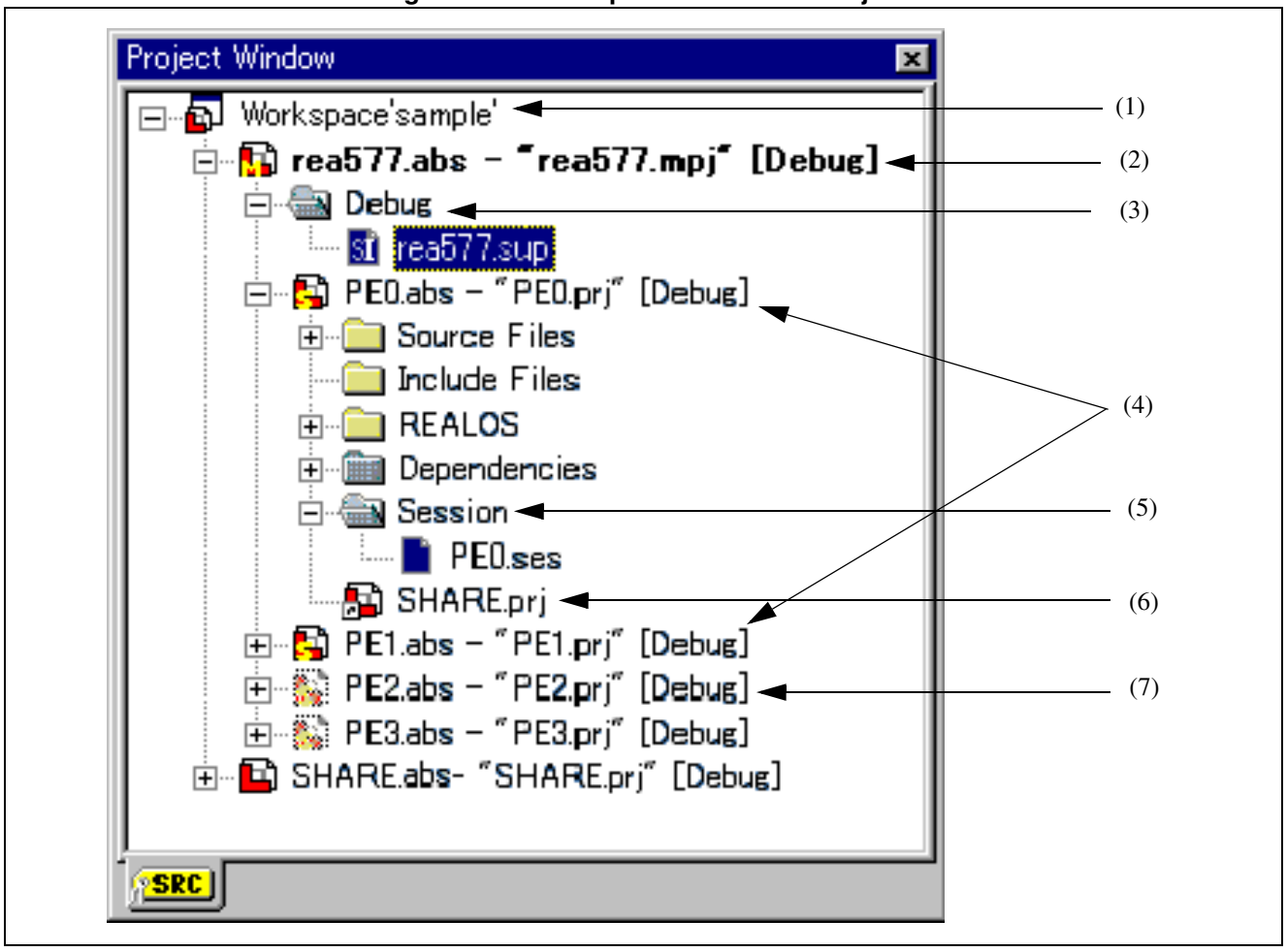


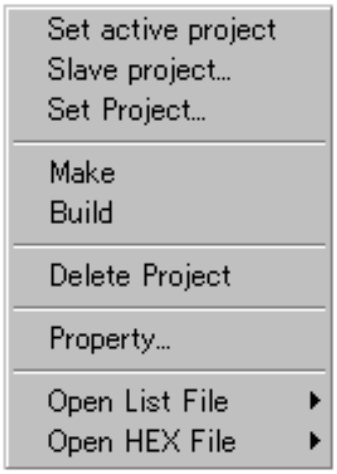
Table 3.4-1 Example of Multi Core Project

(1) Workspace rea577'	Normal workspace
(2) rea577.abs-"rea577.prj" [Debug]	**Master project** for multi-core
(3) Debug	Debugging environment set up file for multi-core
(4) PE0.abs-"PE0.prj" [Debug]	**Slave project** for multi-core
(5) Session	File to be set **session** environment for multi-core
(6) SHARE.prj	Subproject for slave (S0dedicated code/data)
(7) PE2.abs-"PE2.prj" [Debug] PE3.abs-"PE3.prj" [Debug]	**Slave project** for multi-core Because the number of ID exceeds core of MCU, it is not the subject for make, debugging.

■ Short-cut Menu

- Click right button at "Master project"

Figure 3.4-4 Short cut Menu of Master Project



- Set to an activated project

  Set currently selected project to activated project of workspace.

- Slave project

  Choosing this menu will make dialog Figure 3.4-2 to be appeared on a screen.

- Set up of a project

  Choosing this menu will make dialog Figure 3.4-12 to be appeared on a screen.

- Make/Build

  Refer to "3.4.9 Make and Build" for details.

- Delete a project

  Delete a specified project from workspace. Project file itself will not be deleted.

- Property

  Displays information of a file. Refer to "SOFTUNE Workbench Operation manual" "4.3.8 Property" for details.

- Opening a list file

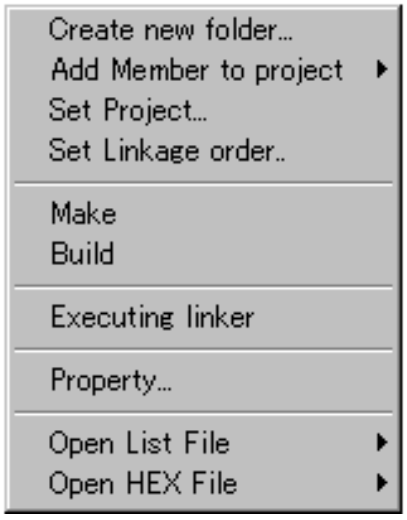
  Select list file to be displayed from sub menu.
  If list file is not created, contents of submenu cannot be chosen.

- Opening HEX file

  Select a HEX file to be displayed from submenu.
  If HEX file is not created, the contents of submenu cannot be chosen.

• Short cut menu of "Slave project"

Figure 3.4-5 Short Cut Menu of Slave Project



- Create new folder

  Refer to "■ short cut menu (Click right button on "Target name")" in "3.4.1 Master Project/Slave Project" for details

- Add a member to a project

  Refer to "SOFTUNE Workbench Operation Manual" "4.5.3 Add members" for adding member to a project.

- Setup of a project

  By selecting this menu, dialog Figure 3.4-13 will be displayed.

- Set up an order of link

  Refer to "■ short cut menu (Click right button on "Target name")" in "3.4.1 Master Project/Slave Project" for details

- Make/Build

  Refer to "3.4.9 Make and Build" for details.

- Star up of linker

  This menu is used to have link of selected slave project.

- Property

  This menu displays the information of a file. Refer to "SOFTUNE Workbench Operation Manual" "4.3.8 Property" for details .

- Opening a list file

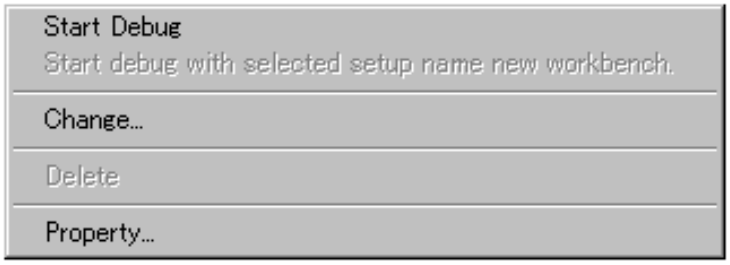
Choose a list file to be displayed from submenu.
If a list file is not created, contents of submenu cannot be chosen.

- Opening HEX file

  Choose HEX file to be displayed from submenu.
  If HEX file is not created, contents of submenu cannot be chosen.

• Shortcut menu of "Setup file of master project"

Figure 3.4-6 Shortcut Menu of "Setup File of Master Project"



- Debugging start/termination

  Debugging Start / terminating

- Start debugging with new Workbench

  Start another Workbench. Refer to "3.7 Duplication of Workbench" for details.

- Set up change

  Change the information of setup for debugger.

- Delete

  Delete information of setup for debugger.

- Property

  Displays the information of file (Refer to "SOFTUNE Workbench Operation Manual" "4.3.8 Property").

• Shortcut menu in "[Session] category"

Figure 3.4-7 Short Cut Menu in [Session] Category

- Addition of set up

  Refer to "■ Short cut menu (Click right button on category "Debug")" in "3.4.1 Master Project/ Slave Project" for details

- Property

  Displays the information of file (Refer to "SOFTUNE Workbench Operation Manual" "4.3.8 Property")

- Shortcut menu in "Session file"

Figure 3.4-8 Short Cut Menu in Session File

- Start/Termination of session

  Connect and disconnect session.

- Setup change

  Change the information of setup for debugger.

- Delete

  Delete information of setup for debugger.

- Property

  Displays the information of file (Refer to "4.3.8 Property").

3.4.1 Master Project/Slave Project

This section explains about master project and slave project.

Master project controls the set up for allocating each slave project, ABS combining tool option, slave project and debugger.

In addition, target program will combine programs for each core and controls combined ABS files.

Slave project will be created accordingly to the number of core when master project is created (Be able to change).

Slave project controls source, include file, and options for each core.

Target file controls ABS file for each core unit.

It is possible to connect session from slave project.

3.4.2 Master/Slave Projects and Composition of Project

This section explains master/slave projects and composition of project.

Composition of project can be created per project for master project and slave project.

By placing a checkmark [To create composition of slave project] when creating composition of master project, it also can create composition of slave at a time.

As for a target file created under multi core environment, composition is different in core target file and all target files.

All target files are created in master project.

Core target file is created in slave project

Following shows the content of each target file.

Table 3.4-2 Composition of Target Filet

	Name of project	Name of target file	Included in information
Master project	Test.prj	Test.abs	Binary of core 0/core1
Slave project 0	Test_S0.spj	Test_S0.abs	Binary of core 0 or debugging information
Slave project 1	Test_S1.spj	Test_S1.abs	Binary of core 1 and debugging information

3.4.3 Sub Project of Master/Slave Projects

This section explains the subproject for master/slave project.

Sub project, which is set to slave, only uses that slave as an object.

When sub project is set to master project in setup dialog "Dependence" , the same sub project as master project are set for all slave projects.

Master project and slave project cannot be set as sub project for other project.

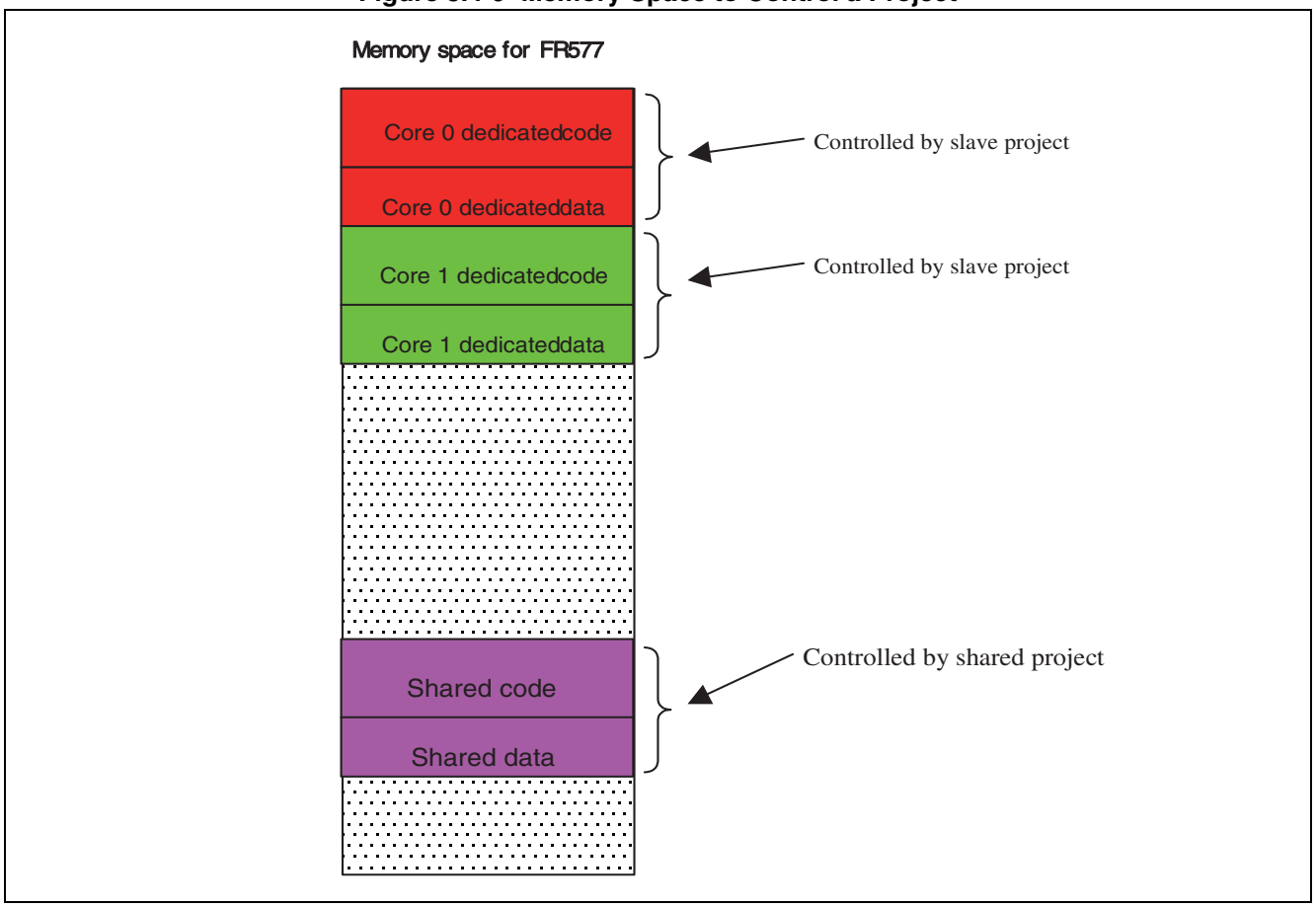
3.4.4 Shared Project

This section explains shared project.

Shared project, which controls shared code/data for multi-core, can be created when "Sharing (ABS) " is selected for a project type.

Register shared project as a subproject of slave project.

Figure 3.4-9 Memory Space to Control a Project

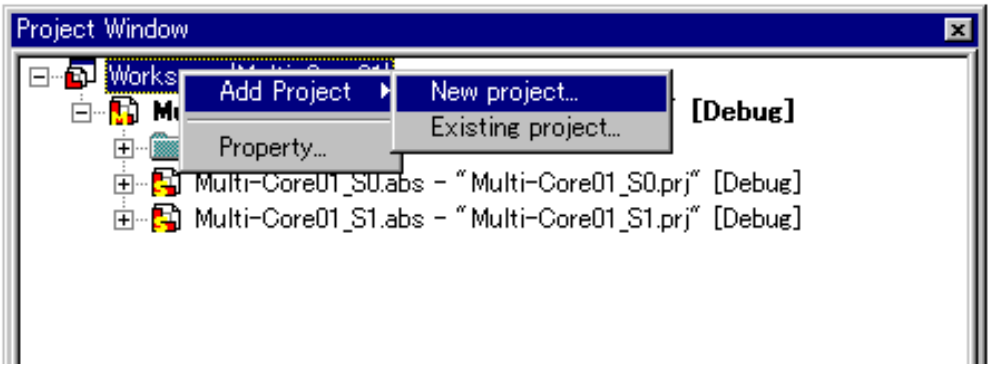


■ Create Shared Project

Click on the right side of workspace in project window, and then shared project can be added to exist product.

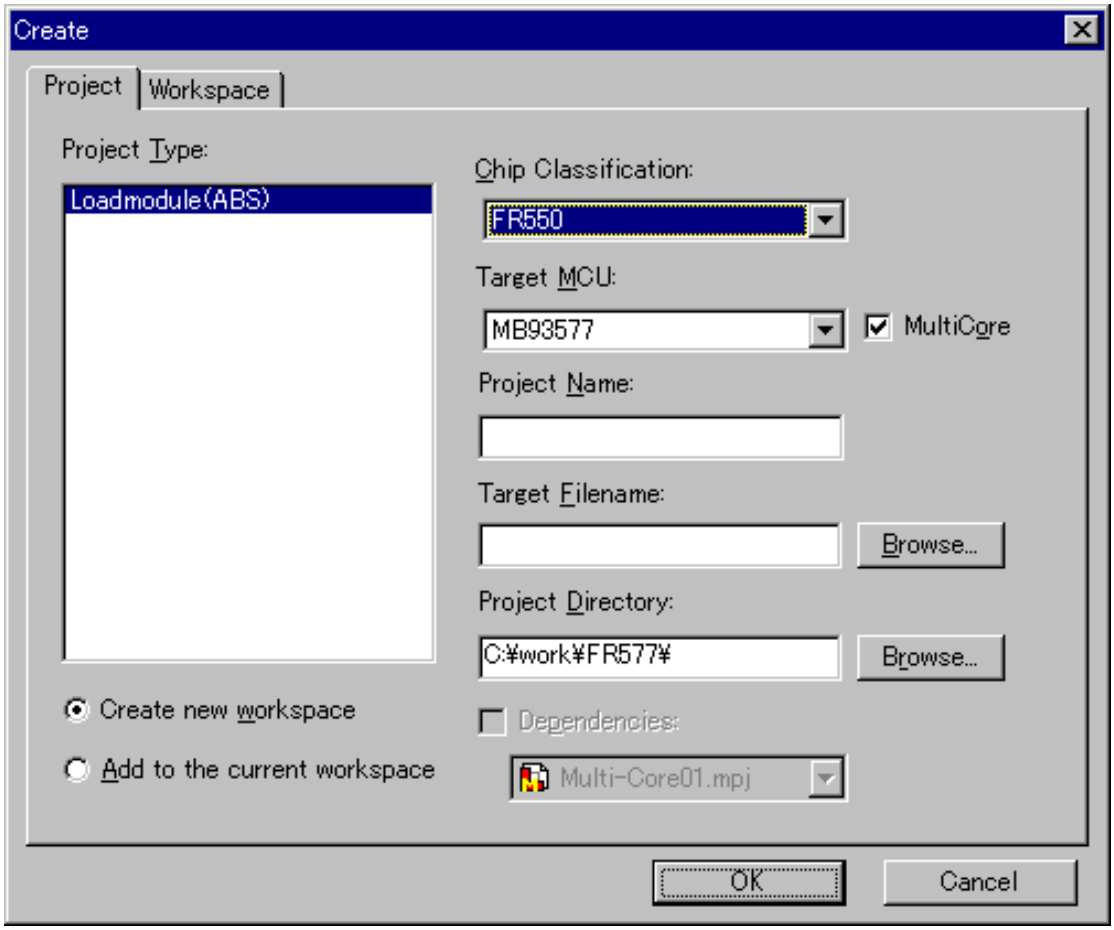
Choosing "add a project and create" from pop up menu will create a new project.

Figure 3.4-10 Popup Menu from Project Window



Removing checkmark from multi-core control can create shared ABS.

Figure 3.4-11 Project Type by Removing Checkmark on Multi Core Control



■ Cautions

There are some cautions need to be considered for shared project as follows.

- Do not make link to library
- Do not use following description in C language

  float Arithmetic

  long long Arithmetic

  Assignment of substitute and arugument passing
- Do not use C++ file
- Write the names of assembler file and section with following style.

  _SHARED_Project name_Configuration name_Section name

  Ex: _SHARED_sample_debug_CODE

3.4.5 Setup of Master Project

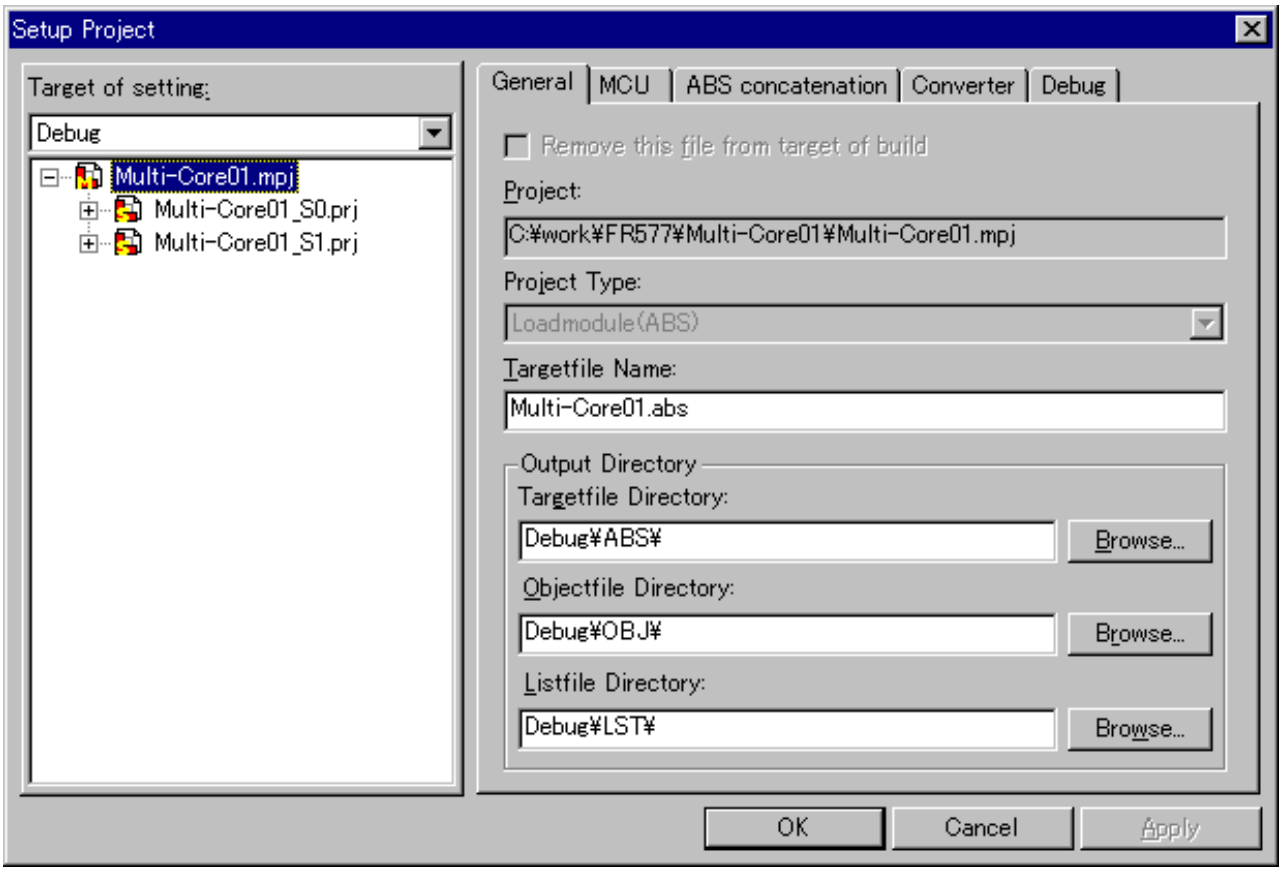
This section explains the setup of master project.

Choose master project from tree "Objected for setup" at dialog "Setup of a project" to set a master program.

Generally, setup of MCU, ABS combining, and setup of converter or debugger can be implemented at master project. Transforming the converter is done at secondary target file where all core are combined. Refer to "3.3.1 Target File at Multi-core Environment" for details of secondary target file.

MCU is configurable per set up (Be able to select only MCU of multi core).

Figure 3.4-12 Set Up of Master Project (in General)



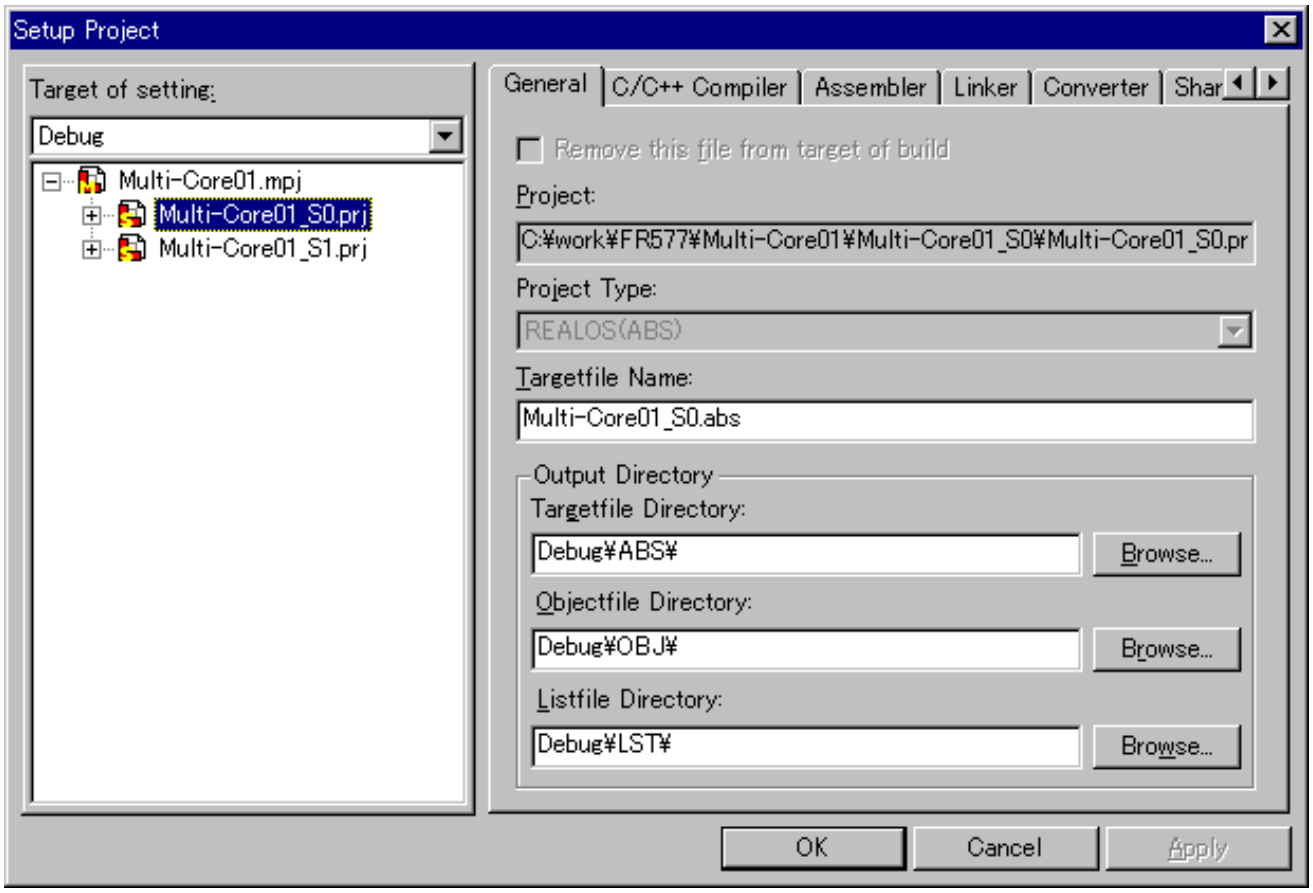
3.4.6 Set up of Slave Project

This section explains the setup of slave project.

Select slave project from dialog (Object for setup) "tree" in order to set slave project. This slave project generally can configure language tool option, and converter. Moreover, session can be added and deleted.

Transforming the converter is done in primary target file that is created by slave project. Refer to "3.3.1 Target File at Multi-core Environment" for details of primary target file.

Figure 3.4-13 Setup of Slave Project (in General)



3.4.7 Set Up of ABS Concatenation Tool

This section explains about ABS concatenation tool.

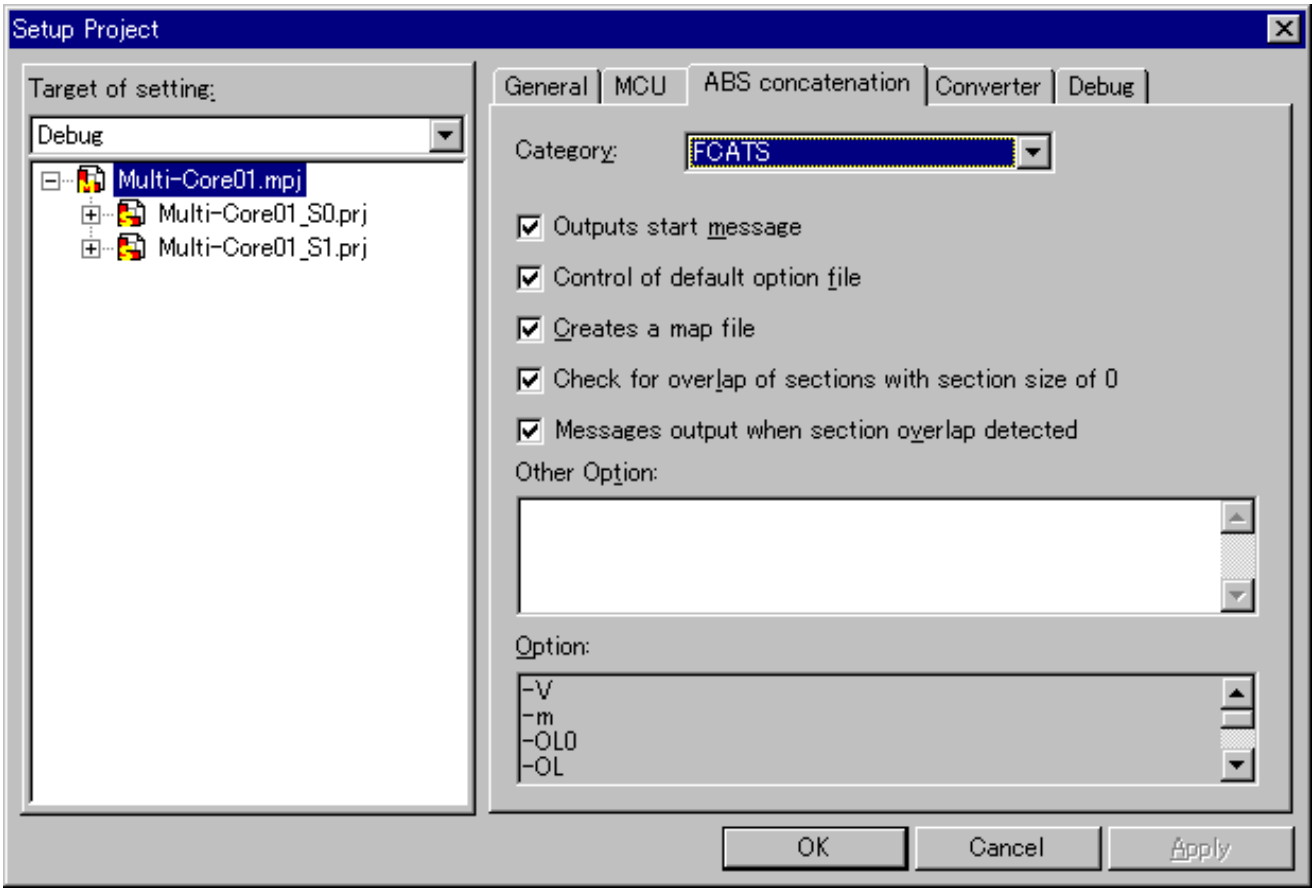
Choose "master project" from (objected for set up) tree in dialog (Set up of a project) for setting ABS Concatenation tool

It is required to choose master project in advance to use ABS Concatenation tool.

Selecting [ABS Concatenation] tab can set an option for ABS Concatenation tool.

Specifying the option for default is shown as following Fig.

Figure 3.4-14 Set Up of Master Project (Concatenation Tool)



Following options can be set.

- Display startup message(-V)
- Suppression of default option file(-Xdof)
- Creating map file(-m)
- Checking for duplication is done for section with its size is 0 (-OL0).
- Output an error message if there is a duplication detected at a section (-OL).

3.4.8 Allocation/Concatenation Sections at Multi-core

This chapter explains allocation/concatenation of sections under multi-core environment.

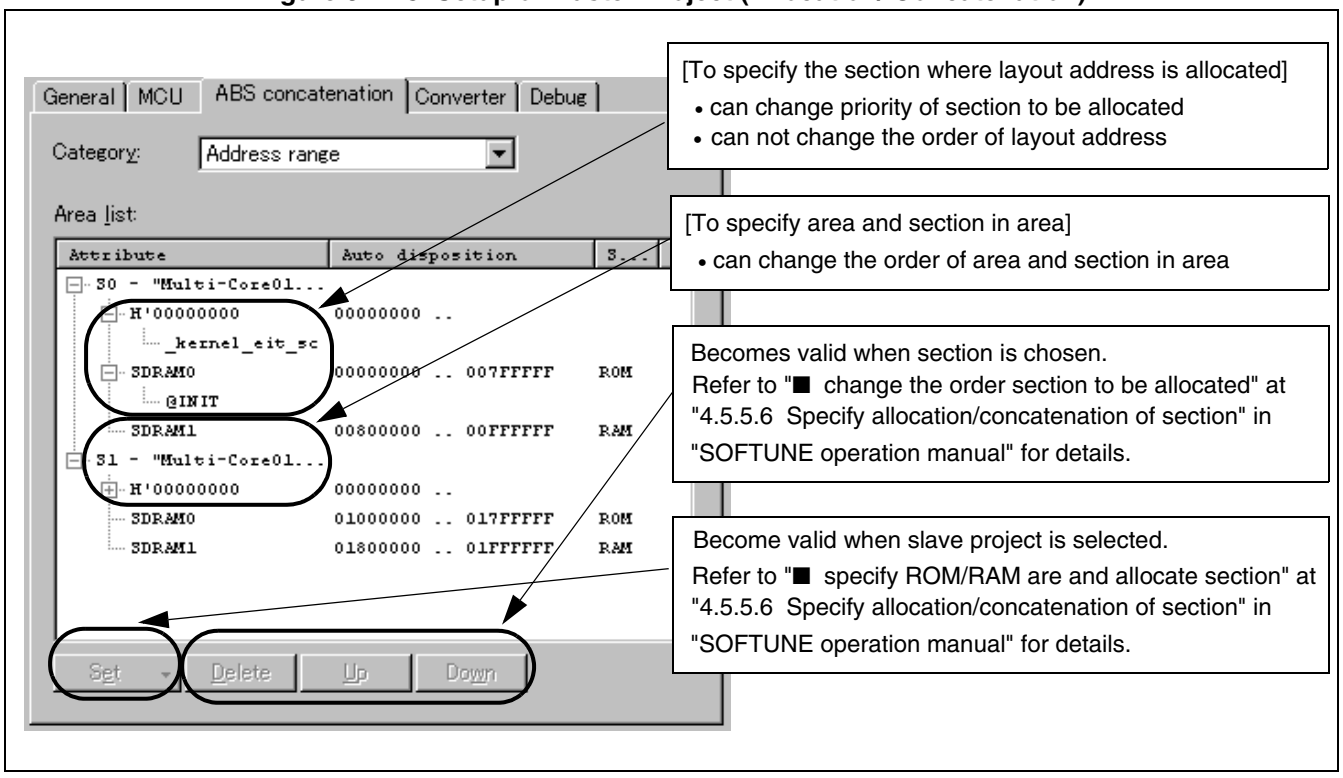
There are two ways used for set-up to allocate and couple sections when ABS is combined.

1. Select slave project from setup dialog in project, then display [Linker] tab.
2. Select master project from setup dialog in project, then display [ABS Concatenation] tab.

In case of 1, it is possible to set linker per core.

In case of 2, it is possible to set allocation/concatenation for all slave project area..

Figure 3.4-15 Setup of Master Project (Allocation/ Concatenation)



■ Caution

The order of ROM/RAM area and section depends on priority set for allocating sections. In addition, priority changes by automatic allocation mode.

3.4.9 Make and Build

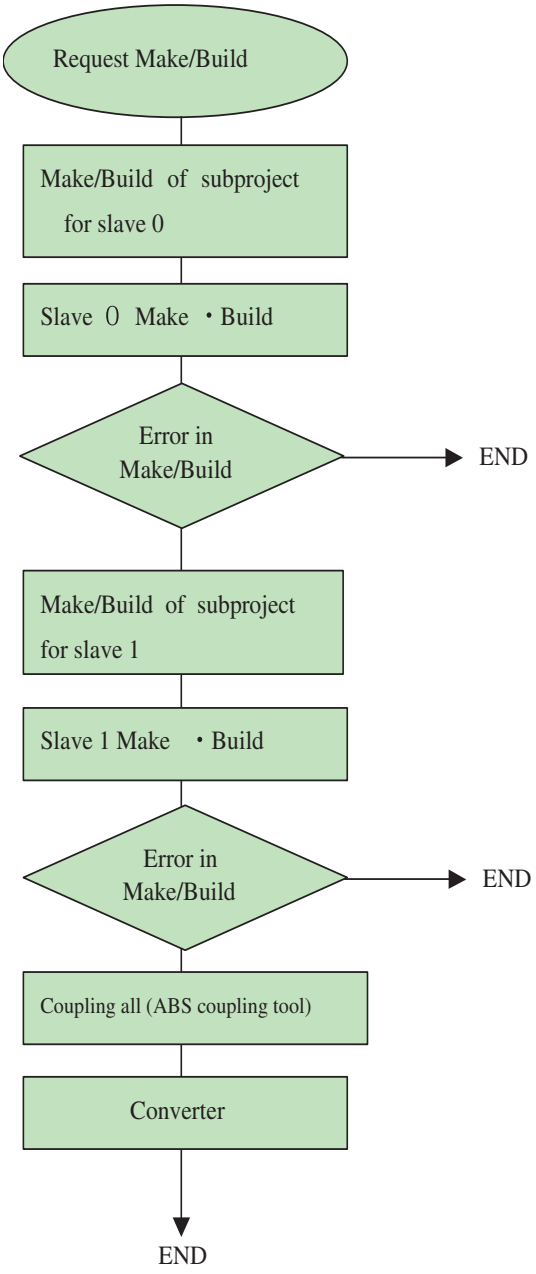
This section explains about make and build.

Shortcut menu in project window is used for process " Make /Build" in one slave project.

When make/build is requested to master project, process "Make/Build" is done as following procedure.

If an error occurs in master or slave project, no disposal is made for slave project.

Figure 3.4-16 Procedure for Make/Build



3.4.10 Customize build

This section explains about customize build.

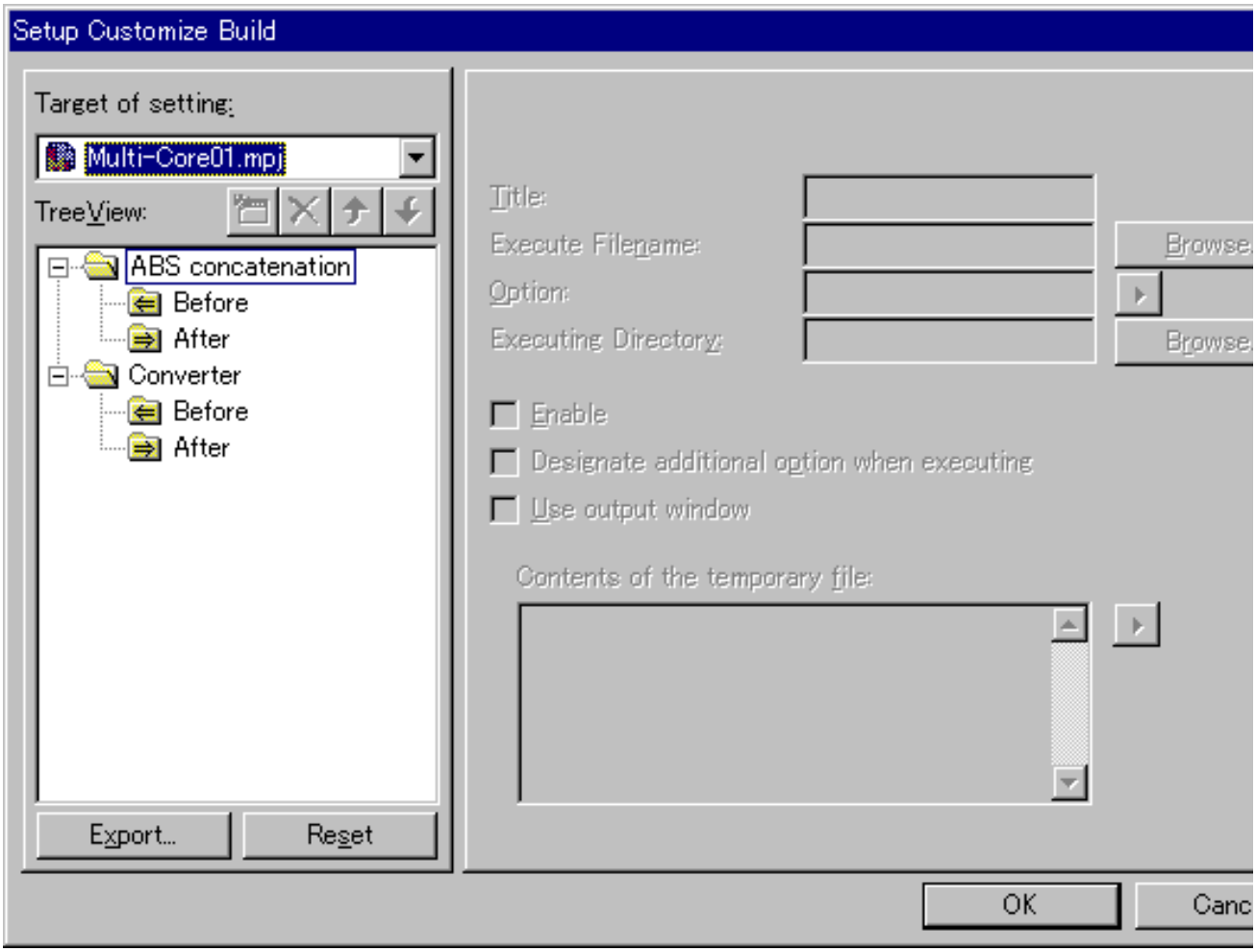
It is required to set "customize build" for each master slave and slave project.

To reflect the setup to master project or to other slave project, setup of currently displayed project can be copied to other project by using [Export] button as other projects.

Only ABS Concatenation tool and converter can be set to master project.

Refer to "1.4.1 Customize Build Function" for details.

Figure 3.4-17 Customize build



3.4.11 Master-Slave Project and Macro Name

This section explains master-slave project and macro name.

When project-related macro is used in master project or slave project, it will be operated as follows.

Following macro names can be replaced with information of slave project. If it is specified by other than master project, macro name will be empty.

Table 3.4-3 List of addressable macro in multi-core project

%(LOADMODULEFILE_Sid)	Passed as full pass name of load module file in slave project
%(PRJFILE_Sid)	Passed as full pass name of project file in slave project
%(PRJPATH_Sid)	Passed as project directory in slave project
%(ABSPATH_Sid)	Passed as target file directory in slave project
%(OBJPATH_Sid)	Passed as object file directory in slave project
%(LSTPATH_Sid)	Passed as file directory in slave project
%(PRJCONFIG_Sid)	Passed as configuration name of project in slave project

Project-related macro except for above (%(PRJPATH), etc.) are determined as follows in a similar manner. Enter ID or core number of debugging.

- In case of customize build, tool option
  - build/make/compile/assemble are implemented by the information of project configuration
- In other cases
  - There is a focus in project window. If valid file name is selected, information will be the activated composition of a project where the file is registered.
  - If valid file name can’t be obtained, information will be activated composition of activated project.

Refer to "1.11 Macro Descriptions Usable in Manager" for details.

3.5 Session

This section explains about session.

Because it is required to control the number of cores with one Workbench under multi-core debugging environment, unit of information correlate with each core is used as session. Each session must have control authority for one core.

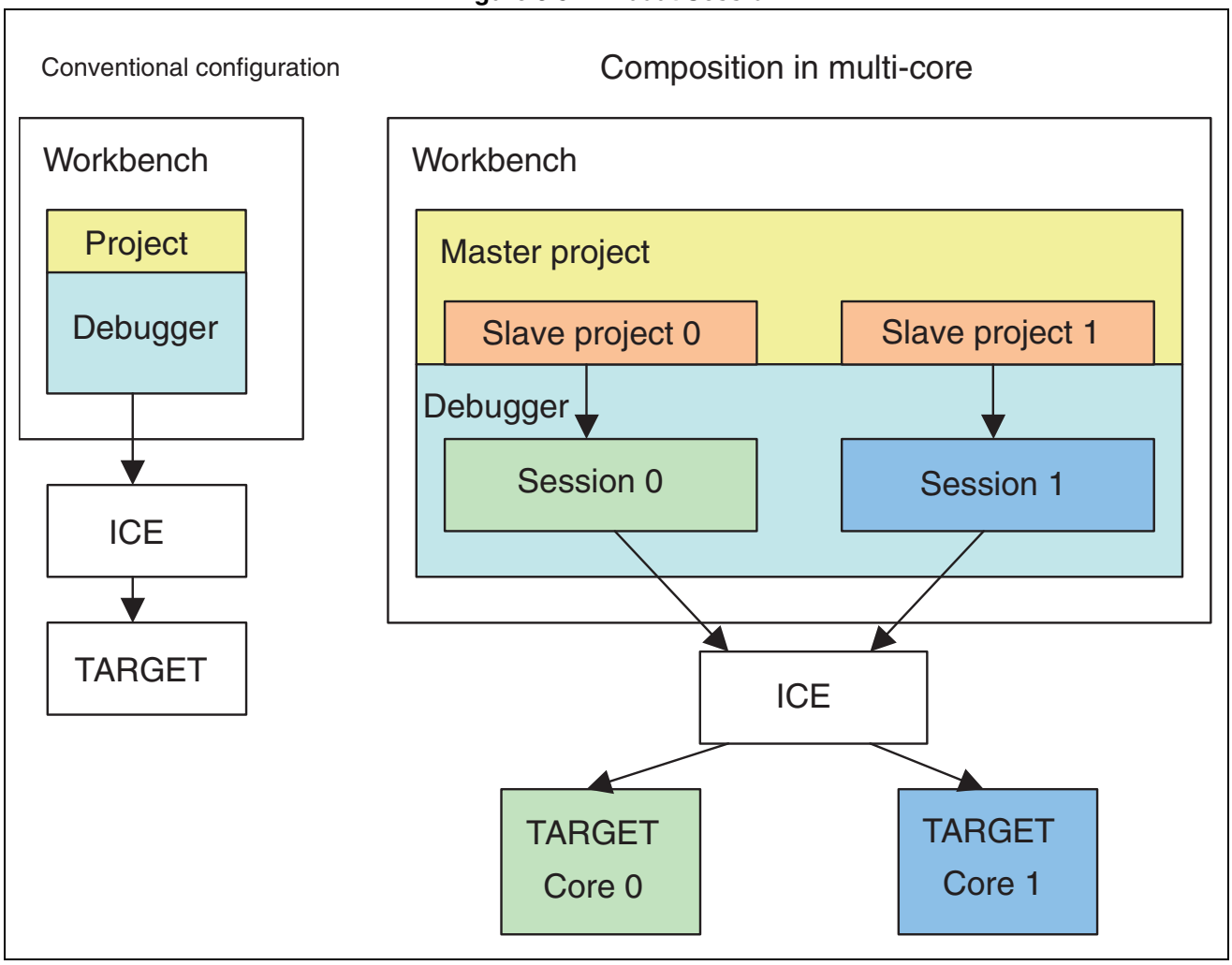
Debugger enables to start the number of sessions. However, only one session is permitted to access with one operation. Thus, it is required to switch session with specified core before accessing to specified core.

- Regarding to attachment/detachment

Attachment is required to make session be accessible.

In addition, detachment is necessary if there is no access to session.

Figure 3.5-1 About Session



3.5.1 What is Current Session?

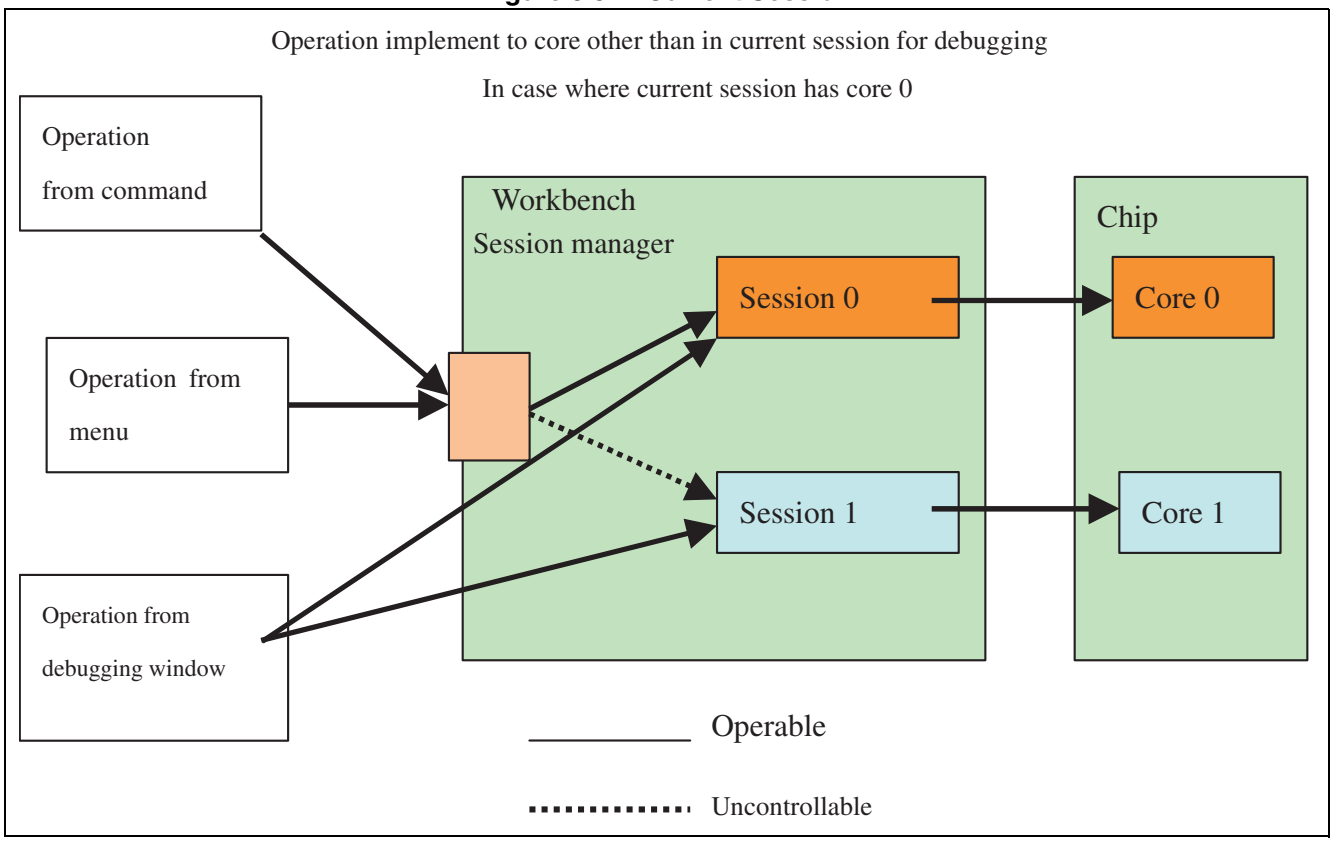
This section explains about current session.

Current session is to indicate the core currently used by users for debugging.

Operation from command and operation from menu will be done for core in current session.

Other core, which is not indicated by current session, can be used for operation from debugging window.

Figure 3.5-2 Current Session



■ Cautions

Operation, which can be affected from current session, is limited to debugging-related function.

3.5.2 Debugging Session and Analysis Session

This section explains about debugging core and analyze core.

■ Debugging Session

This is a session indicated by current session.

■ Analysis Session

Only 1 core among three analysis features (trace, time measurement, performance) is useful in multi-core debugger.

This data collection in this analysis feature is configurable regardless of current session. The core, which uses this analysis feature, is the only one being called an analysis session.

In addition, it is required to set analysis session and current session to the same session to see the result from analysis features.

■ Specify Debugging Session and Analysis Session

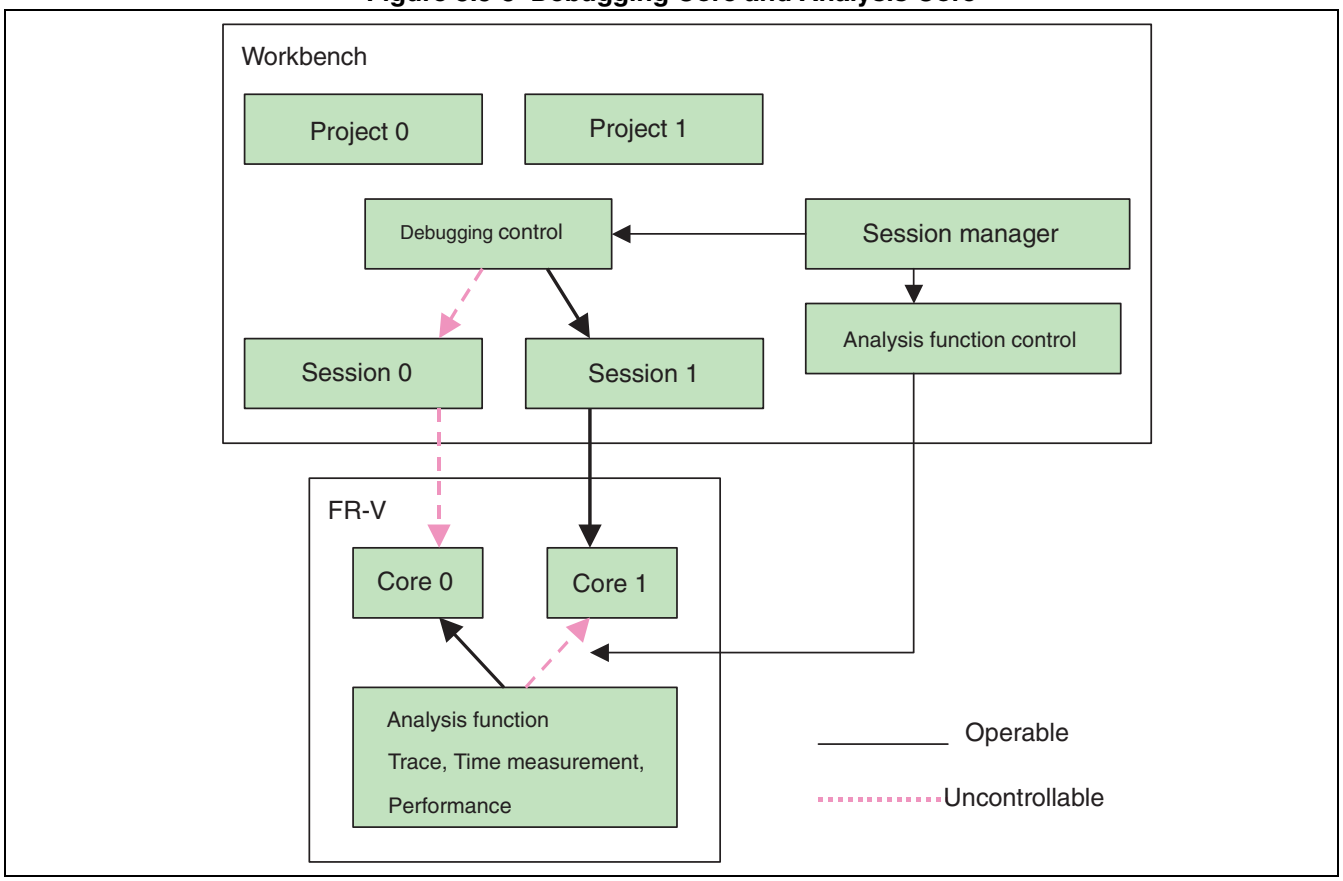
Debugging session and analysis session can be specified from session manager.

■ Cautions for Switching Debugging Session

By switching analysis session, data of [trace], [time measurement], and [performance] will be cleared.

If objected core is in execution when switching analysis session, error [specified session cannot be analyzed] will be appeared and cancel the change.

Figure 3.5-3 Debugging Core and Analysis Core



3.6 Debugging Multi-core

This section explains about debugging function specialized for multi-core.

Following items are explained for debugging function of multi-core.

- Start up of debugger
- Start up of session
- Menu, Toolbar
- Debugging window
- Loading target file
- Software break
- Analysis function

3.6.1 Startup of Debugger

This section explains the start up of debugger for multi-core.

To start up debugger, master project will be used. If debugger is started for the first time after creating a project, setup wizard will be started.

■ Set Up Wizard

Setting items according to need will start debugger.

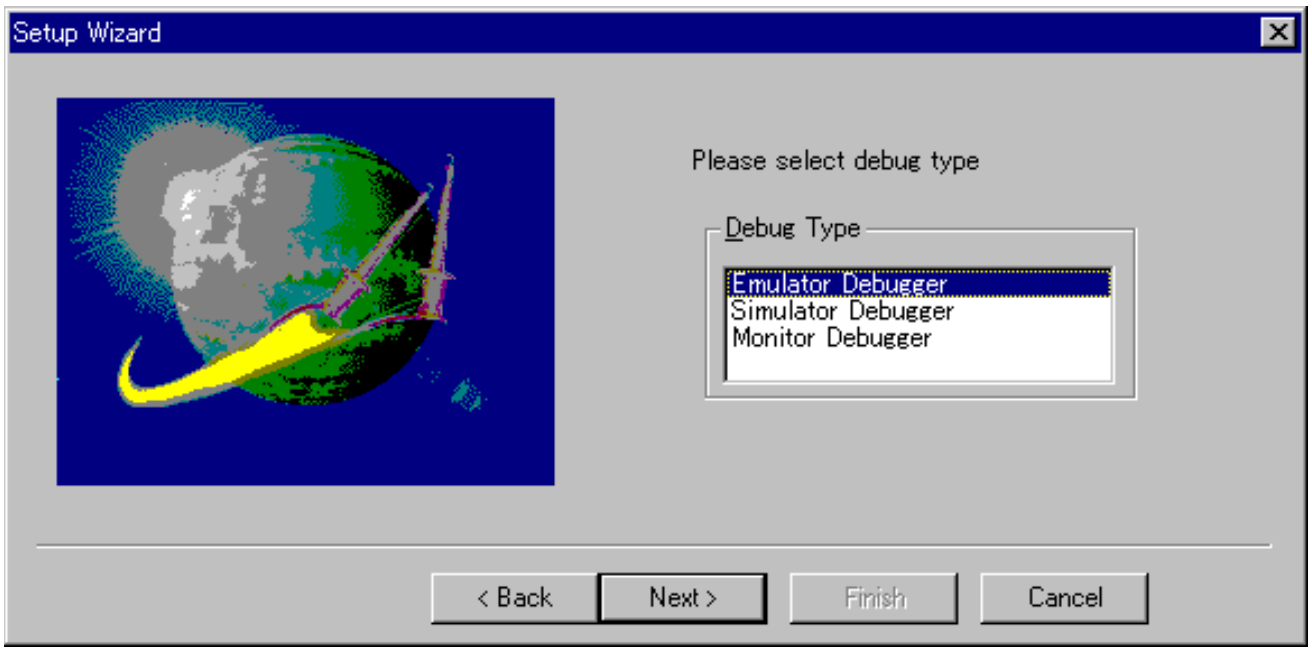
Devices to communicate between emulator debugger and monitor debugger are specified as follows.

- Emulator debugger :USB
- Monitor debugger :RS-232C

Figure 3.6-1 Set Up Wizard (Initial Screen)

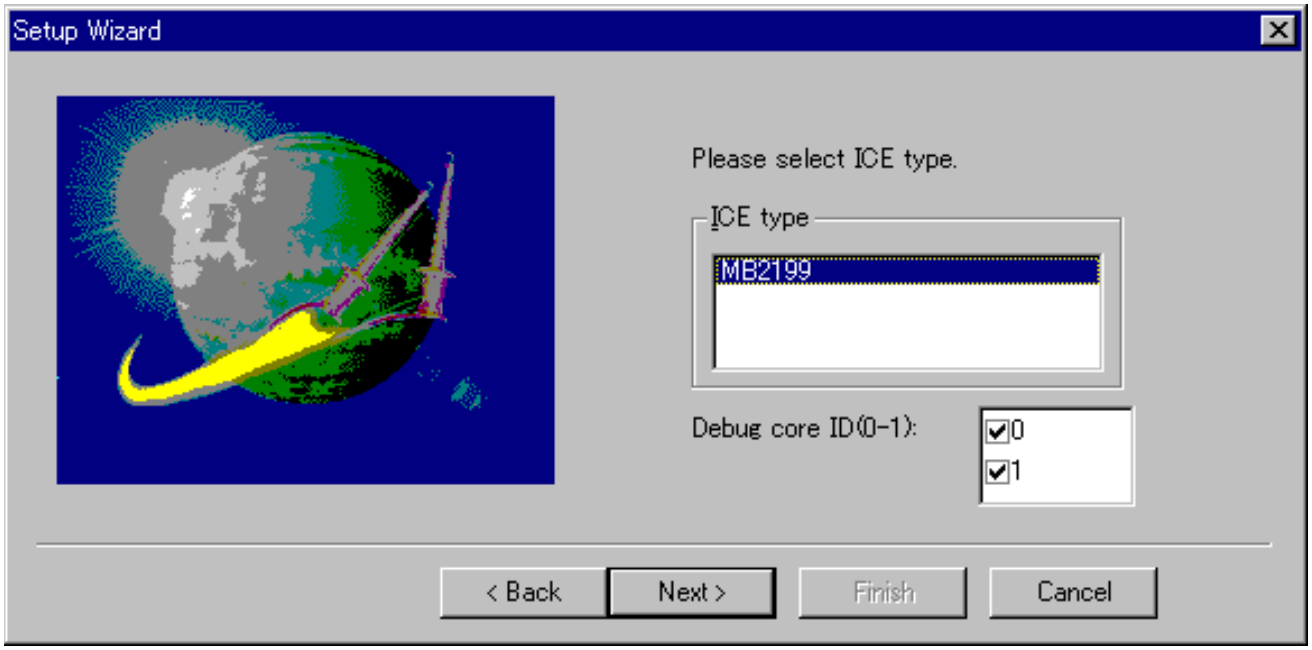
By starting up setup wizard, initial screen will be appeared.

Figure 3.6-2 Set Up Wizard (Type of Debugger)



By clicking [Next] on initial setup screen, the screen will move to [type of debugger]. A debugger can be chosen from three types: emulator debugger, simulator debugger and monitor debugger.

Figure 3.6-3 Set Up Wizard (Type of ICE)

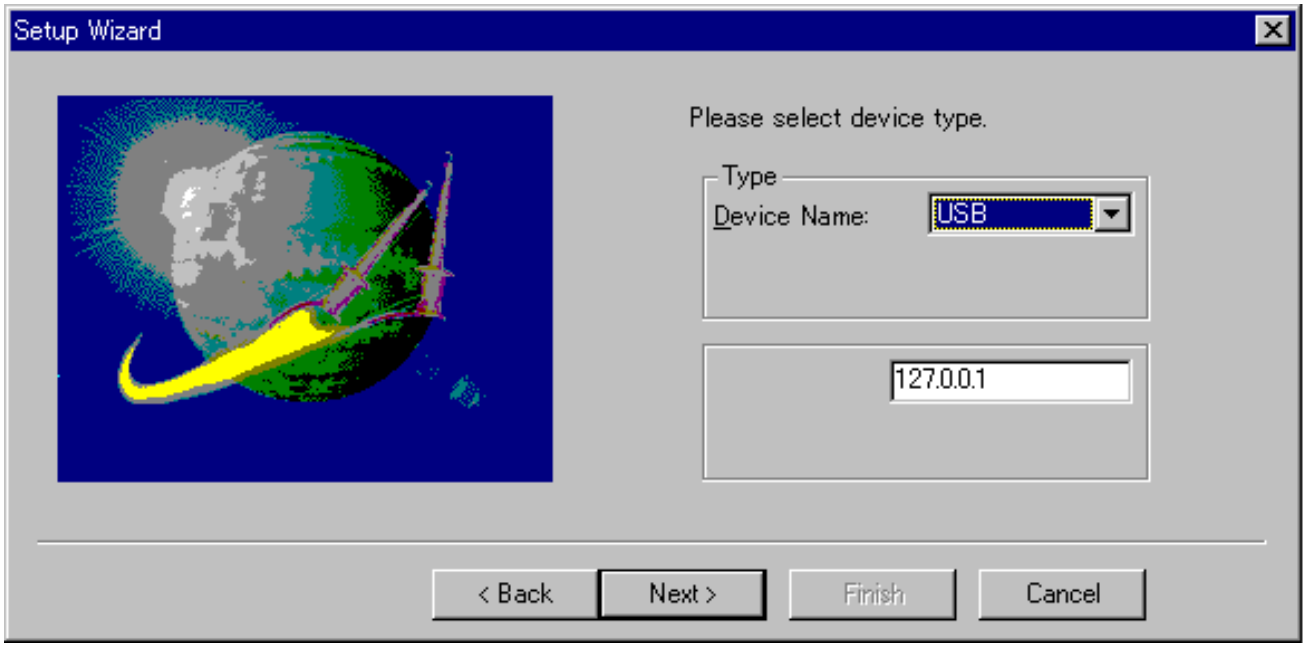


Choose [MB2199] for the type of ICE.

"Debug core ID" sets up connect session implemented after starting a debugger.

By placing checkmark on checkbox of ID, debugging will be started with the condition that core is attached (connected). In default, all cores are attached (connected). It is required to check at least one debugging core. Refer to "3.5 Session" for details.

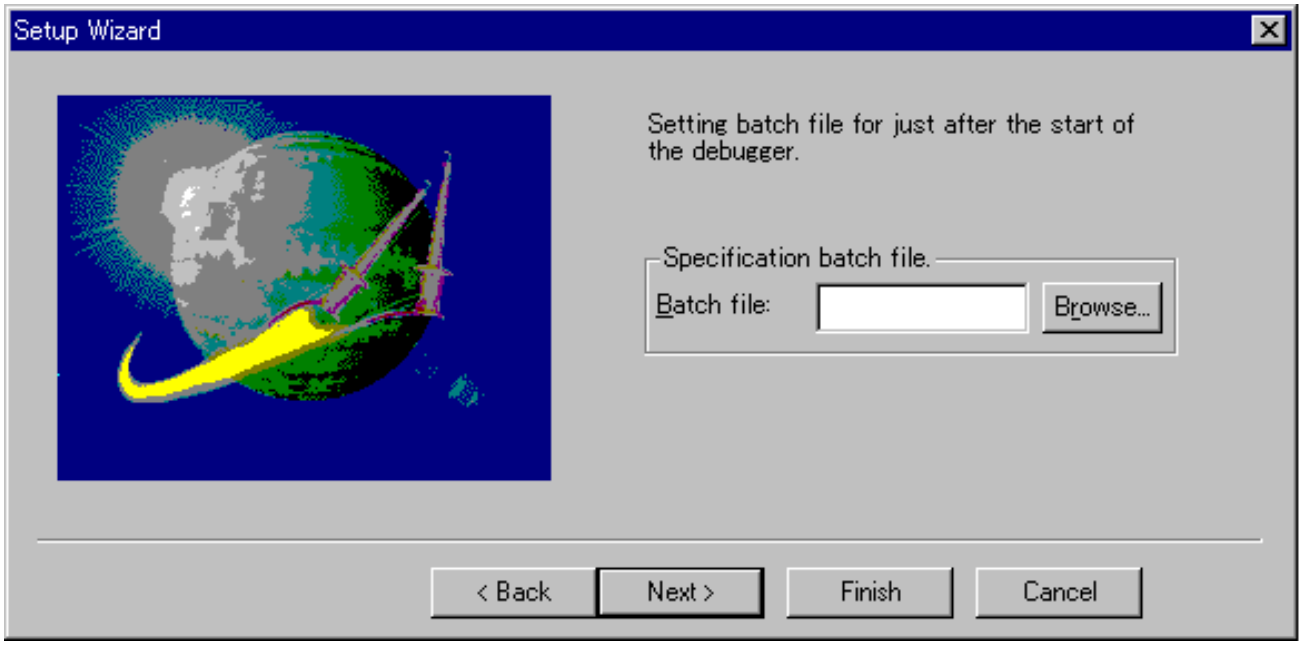
Figure 3.6-4 Set Up Wizard (Type of Device)



By clicking [Next] on ICE type screen, set up for controlling multi-core control will be implemented.

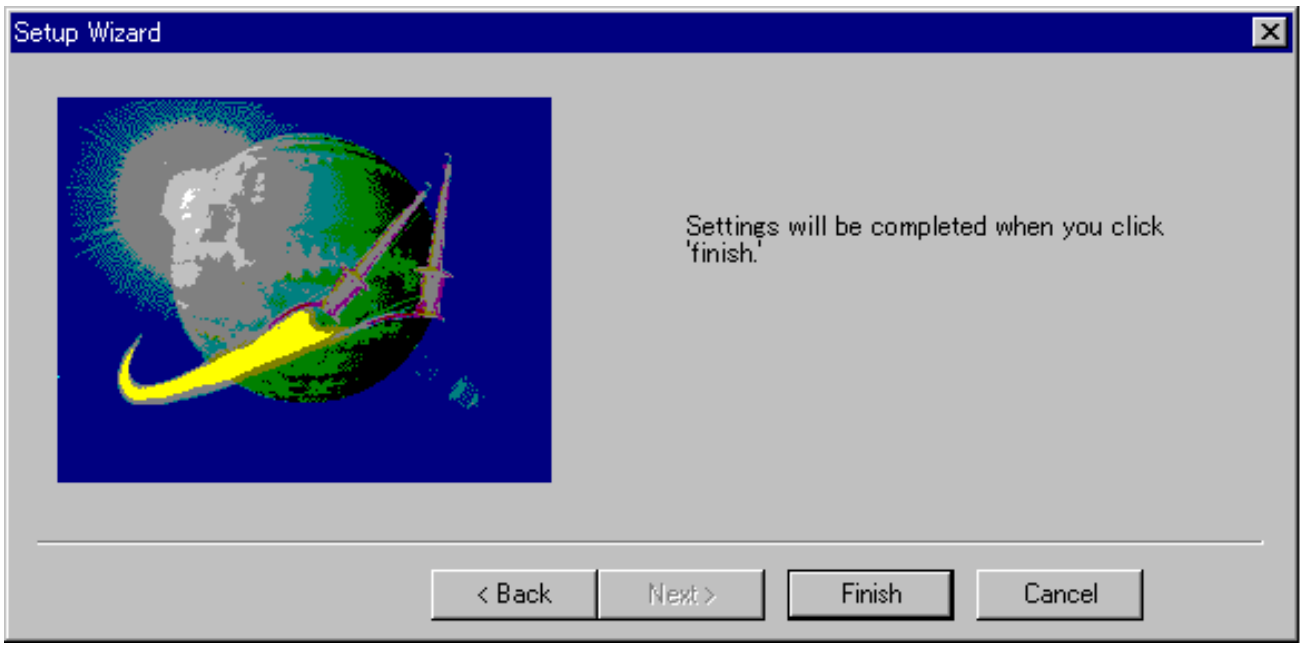
- The name of device :USB (Fixed)
- The name of server :Local host (Default)

Figure 3.6-5 Set Up Wizard (Specify Batch File)



By clicking [Next] on set up screen for device's type, it will specify the name of a batch file to be executed after starting debugger.

Figure 3.6-6 Set Up Wizard (Completed)



By setting a batch file after starting, all setup for starting debugger will be completed. Click [Finish] button to terminate the set up. In order to modify the condition, click [Back] button to see the previous screen.

3.6.2 Connect Sessions

This section explains about connect sessions.

There are three ways to connect sessions.

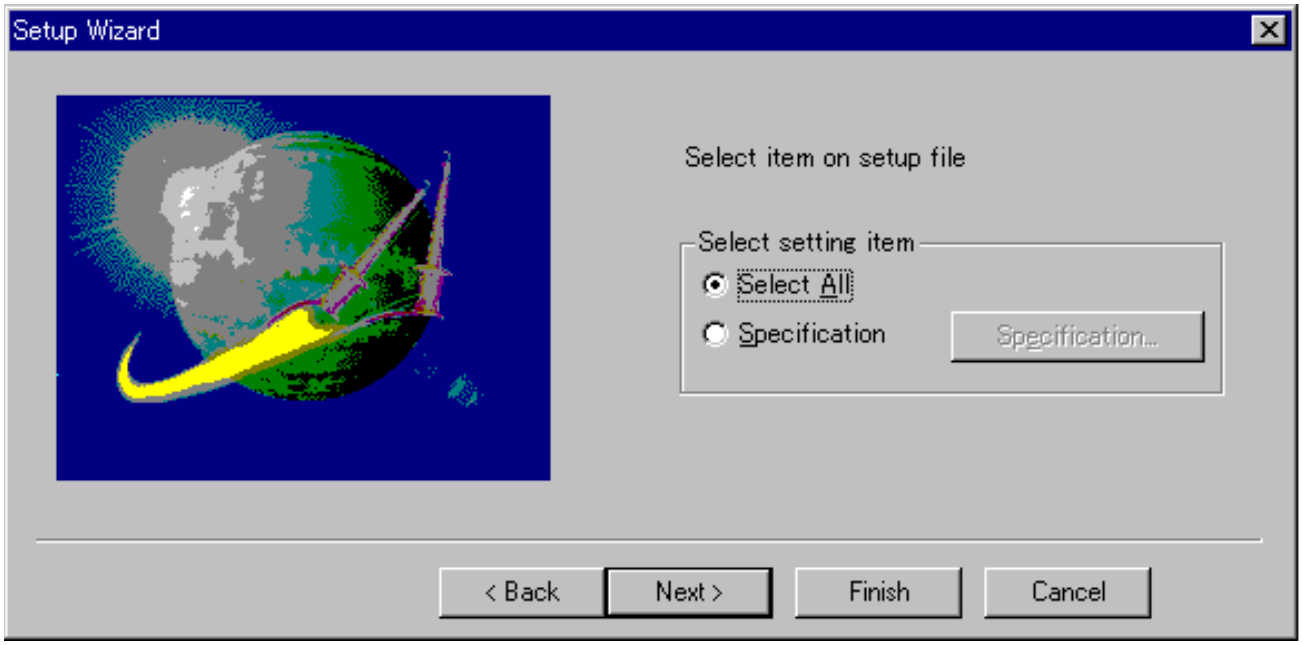
1. Select [Start session] from short cut menu in SESSION folder of slave project
2. Start up from command window
3. Attach session manager to specified core

Number controls sessions, and it corresponds to controlled number of slave project. If session is started for the first time after creating a project, setup wizard will be appeared.

■ Set Up Wizard

Choose items to be set to set-up file per session from this wizard.

Figure 3.6-7 Set Up Wizard (Select Items to be Set)



3.6.3 Menu or Toolbar

This section explains about menu or toolbar.

In case where debugging function needs to be called from menu or toolbar, it means that operation will be implemented for current session.

Refer to session manager or session tool bar for current status of session.

Refer to "3.5 Session" for details

If debugging core is done in different session, switch session by using session manager or session toolbar.

3.6.4 Debugging Window

This section explains about debugging window.

Window for debugging is able to display different status of different session at a time (Except for command window). However, session should be connected (attachment). Color of window title or title bar is set per session. Thus, this enables to distinguish debugging window by color.

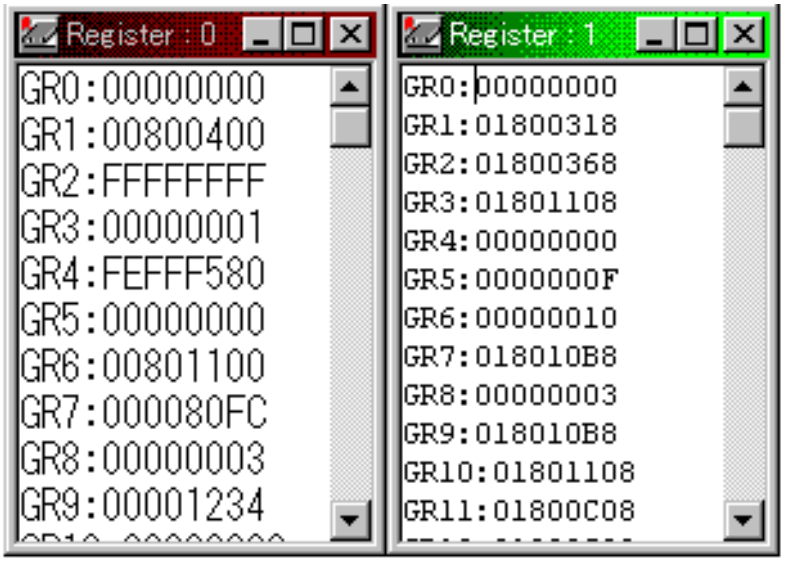
Session 0: Red

Session 1 : Green

Session 2: Blue

Session 3: Yellow

Figure 3.6-8 Example of Debugging Window Per Session

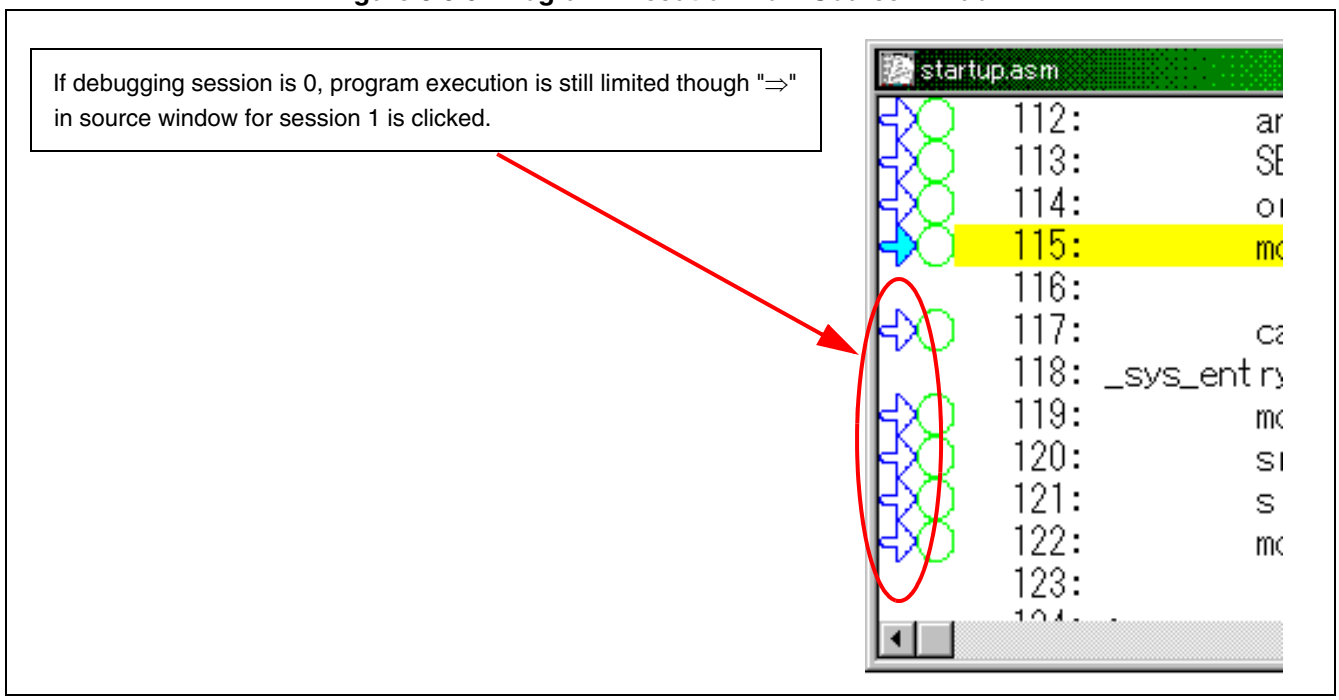


Debugging window can directly to be operated for window independently of current session.

■ Cautions

Program execution by clicking "⇒" in source window or disassemble window, is limited.

Figure 3.6-9 Program Execution from Source Window



3.6.5 Loading Program

This section explains about loading program.

There is a prerequisite that all cores must be halted for loading target file.

Debugger starts loading debugging information in session connected to target file of master program. This process is done in the menu [Debug]-[Loading a target file]. Information to be loaded can be different depending on attachment condition of session.

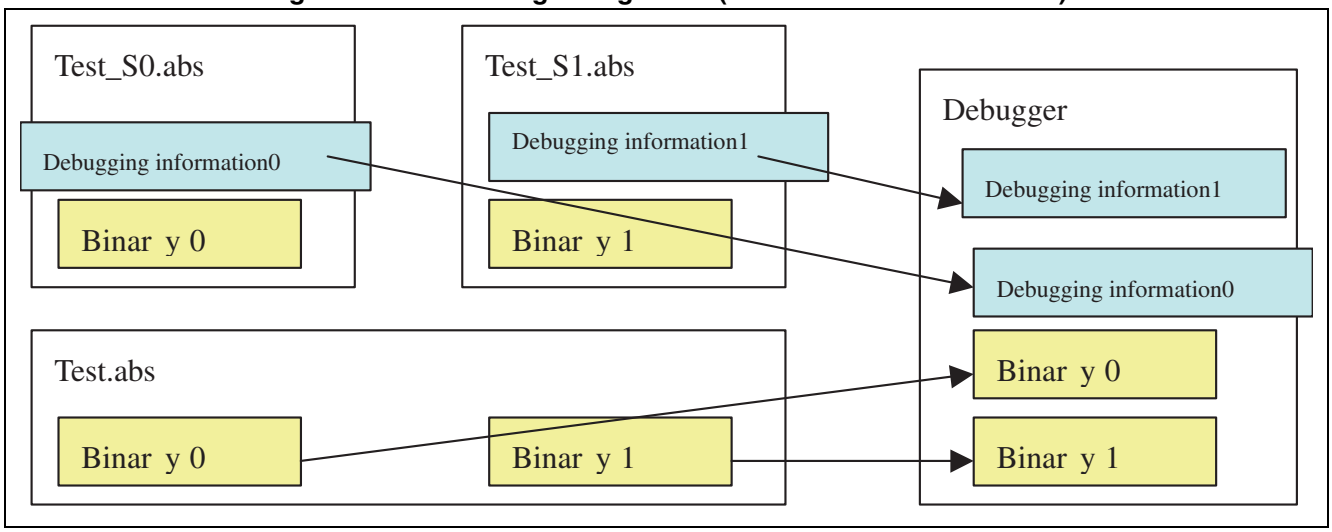
■ In Case where 2 Cores are Debugged at a Time (2 Sessions are Connected)

Load Test.abs

Load debugging information 0 of Test_S0.abs

Load debugging information 1 of Test_S1.abs

Figure 3.6-10 Loading a Target File (2 Sessions are Connected)

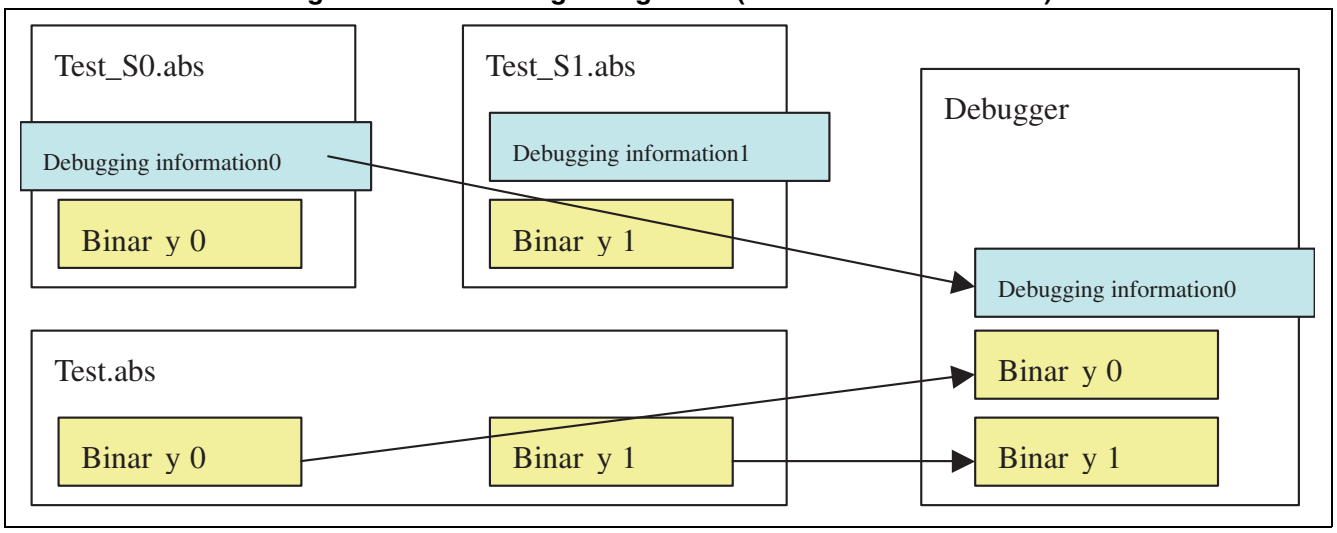


■ In Case where only Core0 is in Debugging (1 Session is Connected, and 1 Session is Disconnected)

Load Test.abs

Load debugging information 0 of Test_S0.abs

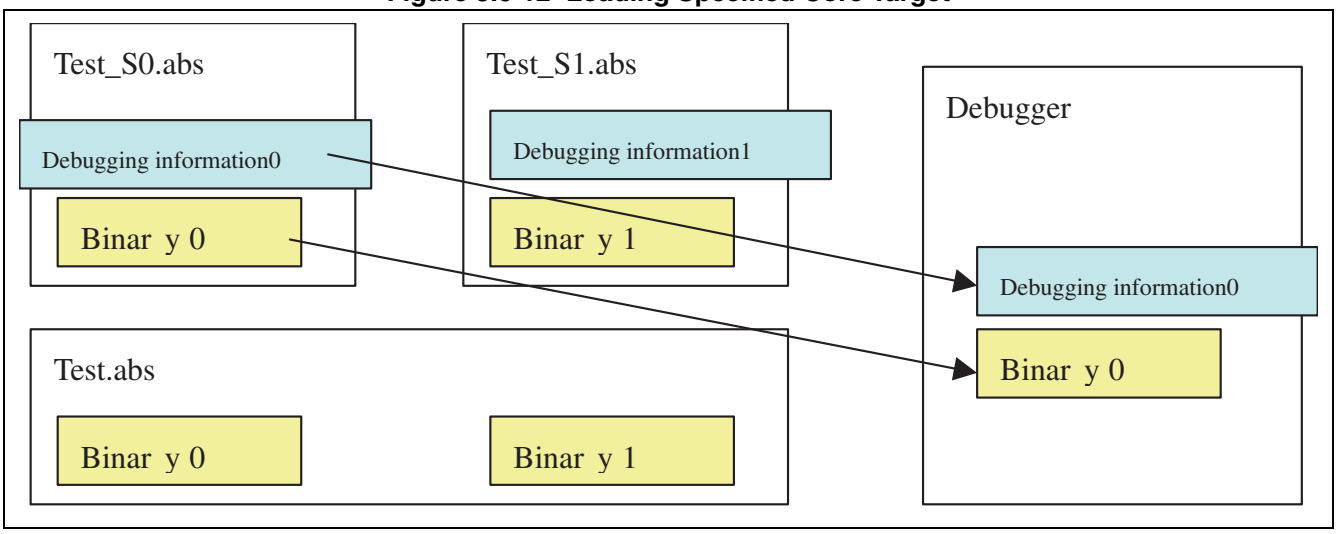
Figure 3.6-11 Loading a Target File (1 Session is Connected)



■ Loading Specified Core Target

It is possible to load specified core target according to need.

Figure 3.6-12 Loading Specified Core Target



Select target file for specified core at dialog [Open a file] in menu [File] - [Open] - [Load module file] or specify the name of target file for specified core with LOAD command.

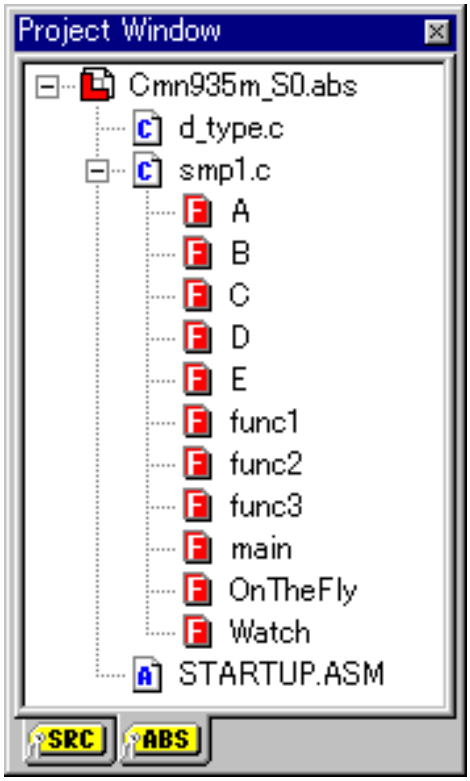
3.6.6 ABS Tab in Project Window

This section explains ABS tab in project window.

Following information will be shown in ABS tab in project window by loading a target file. If debugging information for each core is loaded, ABS tab displays the information of current session.

Contents of display will be updated by switching sessions.

Figure 3.6-13 ABS Tab in Project Window



3.6.7 Break

This section explains about software break and hardware break.

- Software break

  Software break is limited to 4096 points for all cores. Thus, addressable points in one core are 4096/the number of core.

  If there are 2 cores, software break can be addressed till 2048 pcs for 1 core.

- Hardware break

  The number to be set to hardware break is determined by core for multi-core debugger.

■ Cautions

If software break is set to shared code, it will be halted independent of core 0 or core 1.

3.6.8 Synchronous Execution and Synchronous Break

This section explains about synchronous execution and synchronous break.

- Synchronous execution
  This is an execution function to specify cores that also execute with specified core at the same time.
- Synchronous break
  This is a break function to specify a core that breaks with specified core at the same time.

■ Cautions (1)

Synchronous break is only configurable when core is halted or during reset.

Refer to "4.7.2.5 Session manager" in "SOFTUNE Workbench Operation manual" for details.

■ Cautions (2)

Using session manager or GO/CORE command does not set synchronous execution and synchronous break if monitoring is invalid.

Also, it is not possible to set monitoring if synchronous break and synchronous execution are valid.

Figure 3.6-14 Setup of Monitoring

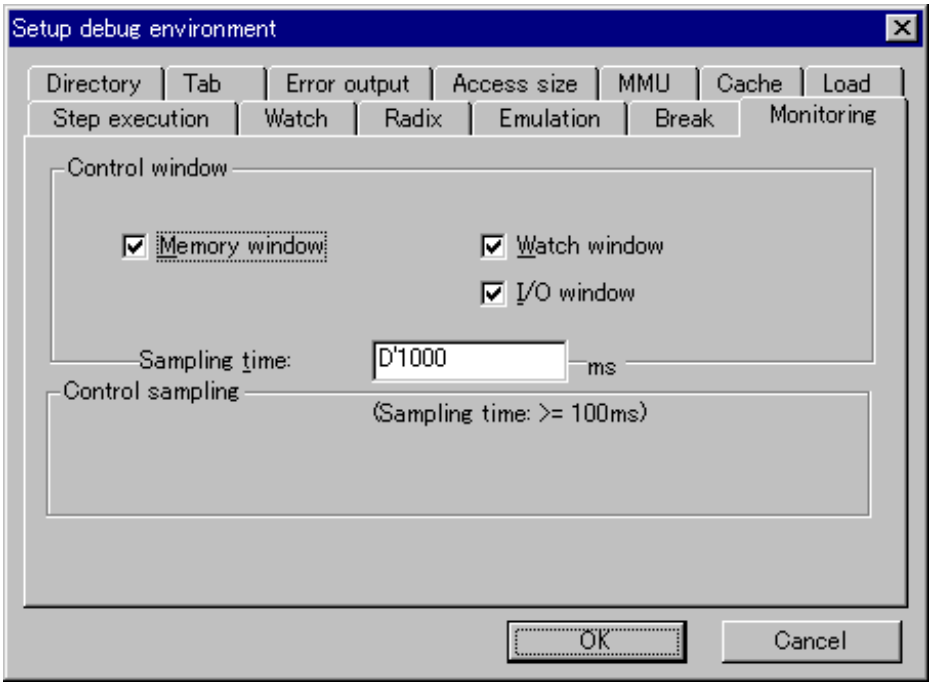
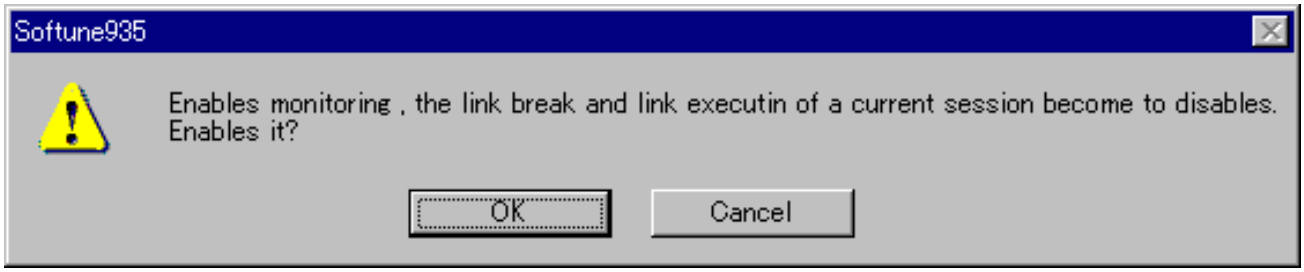


Figure 3.6-15 Cancellation of sYnchronous Execution when Monitoring is Valid


Softune935
Enables monitoring , the link break and link executin of a current session become to disables.
Enables it?
OK
Cancel

3.6.9 Analysis Feature

This section explains about analysis feature.

It is required to choose core to be used for analysis in multi-core debugger in advance. Other core cannot be used for analysis. Following features are equipped for analysis feature.

- Trace
- Time measurement
- Performance

Even though trace window is opened in session where analysis feature is invalid, contents will not be displayed.

Refer to "3.5.2 Debugging Session and Analysis Session" for details.

3.7 Duplication of Workbench

This section explains about start up the method to control the number of Workbench with duplicated Workbench.

It is possible to start another Workbench from currently used Workbench. Duplicated Workbench shares the same project with other.

In this instruction manual, originally working Workbench is called Original Workbench and duplicated Workbench is called as Duplicated Workbench.

- Start duplicating
- Terminate duplication
- Start/terminating debugging
- Creating target program
- Downloading a program

3.7.1 Start Duplicating

This section explains about to start up of duplicated Workbench

■ Software Breaks

Select master project from project window to start up duplicated Workbench.

Then click the right button to make a menu appear on a screen after choosing the member of Debug folder. Then, execute [Start debugging new Workbench] in menu.

However, there are some cautions for following points to start duplicated Workbench.

- Unless there is at least one detachment session, Workbench will not be started.
- If core is in reset, start up can be executed in a status as shown in Figure 3.7-4.
- Duplicated Workbench starts at the same time when debugging is started.

Figure 3.7-1 Session Bar to Indicate whether S1 Cancels Reset or not

Figure 3.7-2 Start Up of Duplication

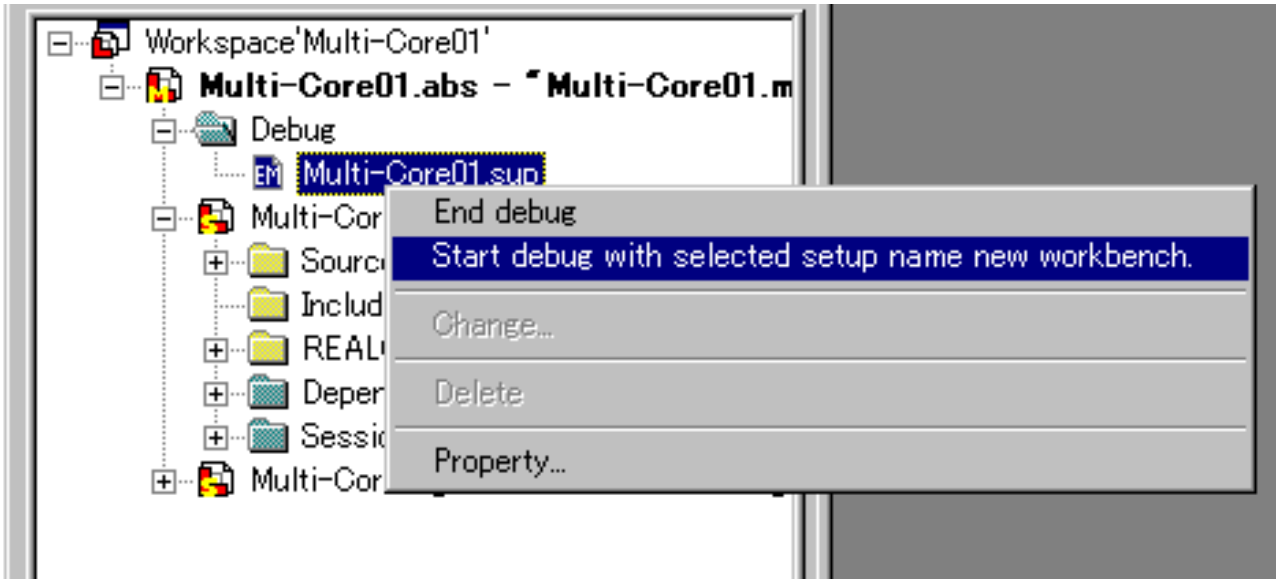


Figure 3.7-3 Error to Start a Duplication when there is no Detach

Figure 3.7-4 Start a Duplicated Workbench with Reset not being Cancelled

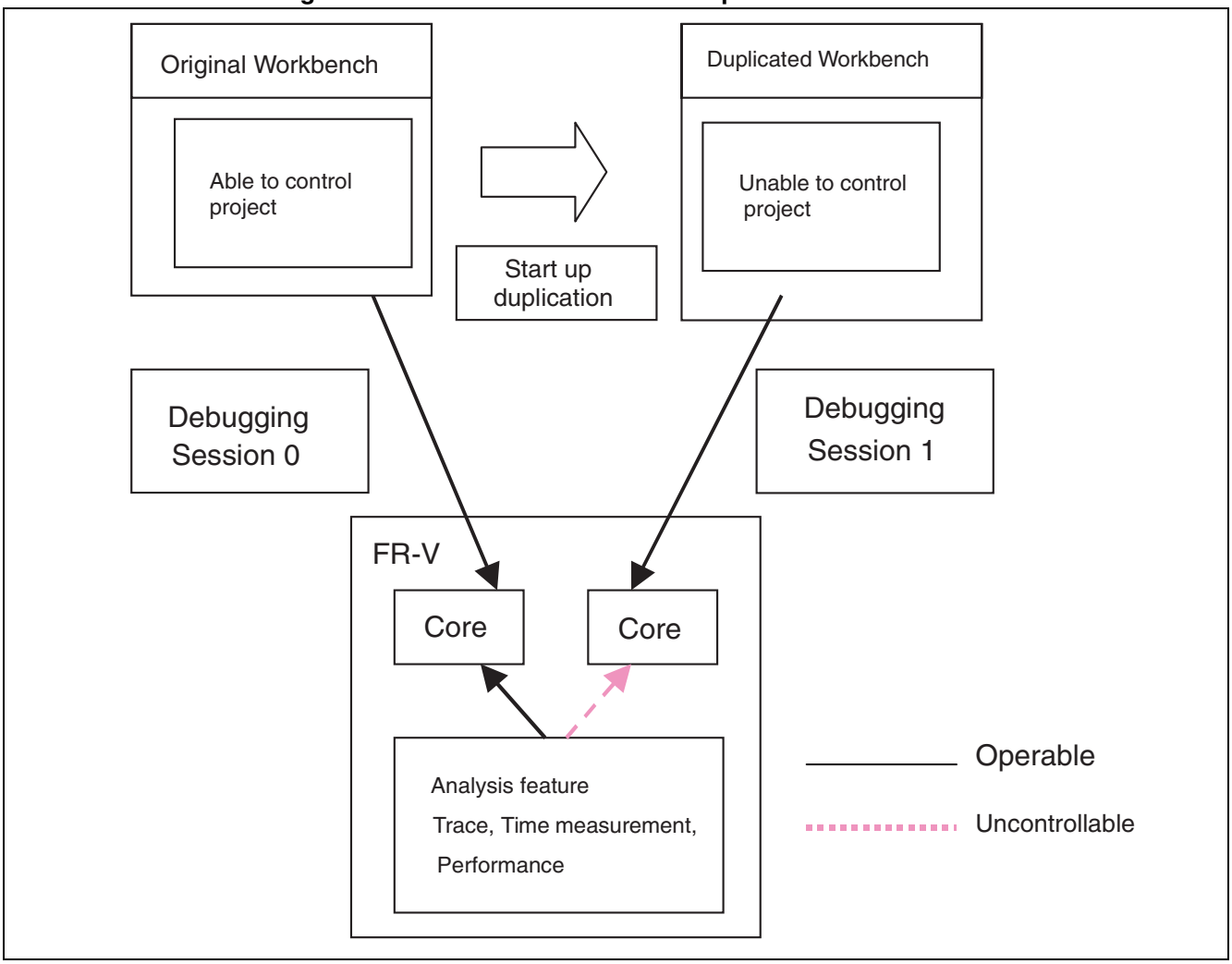
Finally, duplicated Workbench will be started.

■ Cautions

There are some following restrictions on duplicated Workbench.

- Cannot change the setup of project (Except for editing source file)
- Call an original Workbench to implement Make/Build

Figure 3.7-5 Core that can Control Duplicated Workbench



3.7.2 Termination of Duplicated Workbench

This section explains about termination of duplicated Workbench.

By terminating to debug a duplicated Workbench, it also will stop a duplicated Workbench.

In order to stop an original Workbench, it is necessary to finish duplicated Workbench by force. Then original Workbench will be terminated.

■ Cautions

If duplicated Workbench is in process, an original Workbench cannot be terminated.

Wait for a duplicated Workbench process to be completed, and then finish an original Workbench.

3.7.3 Creating and Loading Target File

This section explains the method for making and loading target file with duplicated Workbench.

- Create a target file

  When creating a target file (Make/Build) in duplicated Workbench , no operation can be done at duplicated Workbench. Instead, target file will be created at an original Workbench.
- Loading a target file

  It is possible to download a program from duplicated Workbench.

  An original Workbench always does this operation.

3.8 Command

This section explains about command and intrinsic function.

Following explains command and intrinsic function added to multi-core debugger.

- Command
- Intrinsic function

3.8.1 Command

This section explains about command.

■ Trace

Command is extended for controlling session. Normal debugging command is used as a command for current session.

It is possible to download only a target file in specified session for loading a target file.

Refer to "Command Reference Manual Chapter13 Multi-core control command" for details.

- Session control

ATTACH SESSION	To start a session ATTACH is done for core. If it succeed, startup is completed.
DETACH SESSION	Disconnect session DETACH a core
SHOW SESSION	To display session list that are currently opened Also, this displays the status of analysis core.
SELECT SESSION[/DEBUG]	To change session as a object for debugging (Select debugging core)
SELECT SESSION[/ANALYZE]	Select core for analysis When analyze core is specified, following debugging functions can be used from the core in session. • Trace • Performance analysis • Time measurement

- Synchronous control

SYNCHRONIZE BREAK	To set synchronous break between sessions
SYNCHRONIZE EXECUTE	To set synchronous execution between sessions

- Go control

GO/NOWAIT	Execute a program, but command will be finished without waiting for break Can not specify temporary break.
GO/CORE	Execute per core
GO/WAIT	Execute a program and waits for break

- Load control

LOAD/TARGET	Loading a target file
LOAD/TARGET session-ID	Loading debugging information of specified session

- Add-in control

EXTRA [key-word command]	Parameter delivered to add-in that has specified keyword key-word : COACHER RANALYZER command : Refer to the specification of command for each add-in to support EXTRA command.

3.8.2 Intrinsic Function

This section explains intrinsic function.

Using extended intrinsic function makes easy to create procedure file for multi-core control.

Refer to "Command Reference Manual Chapter 14 Built-in Variable and Functions" for details.

- Session control

%MP_GET_ACTIVE_SESSION	Obtain current session ID
%MP_GET_STATE_SESSION	Obtain the status of specified session
%MP_GET_CORESTATE	Obtain an operational status of specified core
%MP_EVAL_SYMBOL	Evaluate a symbol of specified session
%MP_EVAL_SPR	Evaluate SPR register

3.9 Cautions for Multi-core Debugging

This section explains about cautions for multi-core debugging.

■ Status of Each Core from the Beginning of Debugging

Following shows the status of core from the beginning of debugging.

Name of core	Status	Debugging
Core 0	Break	Possible
Other than core 0	Keep reset condition	Uncontrollable

Core other than 0 keeps reset condition until cancellation for reset by core boot control register (CBCR)* is permitted.

Once reset is cancelled, debugging becomes possible.

*:Refer to "LSI specification for core boot control register" for details.

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